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ORIGINAL MEMOIRS.

THE SERUM THERAPY OF TETANUS.*

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As the title of this paper indicates, its scope is restricted to a consideration of the therapeutic value of the antitoxin treatment of tetanus. However, it is essential in order to obtain a just estimate of the value of the antitoxic serum that we appreciate certain principles which laboratory investigation seems to have firmly established, and that we study carefully our clinical experiences.

The Tetanus Bacillus.—Tetanus is essentially a dirt disease. Its etiologic agent, the tetanus bacillus, commonly inhabits the surface dirt, and yet it belongs to the class of bacteria incapable of developing in the presence of atmospheric oxygen.

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It has been definitely shown by Debrand¹ and others, however, that oxygen-consuming bacteria, by using up the available oxygen in their development, create the proper anaërobic conditions necessary for the growth of the tetanus bacillus. This symbiotic growth of aërobic and anaërobic bacteria is an exceedingly common phenomenon in nature.

The tetanus bacillus and its spores have a most tenacious vitality and can live under natural conditions entirely unfavorable for the existence of most pathogenic bacteria. Living spores can exist in dust and other dry dirt.

The bacillus thrives best at the body temperature, and can develop but little, if at all, below 60° F. On this account it may be assumed that the organism is more active during the summer months. One of us has shown² that the large majority of cases of tetanus in New York State occur from May to October, with June, July and August as the months of maximum activity.

That it is a frequent habitant of the intestinal tract of animals, especially horses and cattle, has been amply shown by numerous workers, but more recently by Hoffman.³ This fact is important, as all wounds received in stables or contaminated with animal discharges are particularly to be feared. Pizzini⁴ has also found it in the fæces of man. Tavel⁵ and Libman⁶ describe an anaërobic spore-forming tetanus-like bacillus in the human appendix.

In this connection reference should be made to the clinical evidence of the source of infection in man being sometimes in the intestinal tract.

In Table I accompanying this paper are five cases following operations performed under aseptic conditions upon

¹Debrand. *Annales de l'Institut Pasteur*, 1902, 16, 427.

²Pease. *Medical Review of Reviews*, 1904, x, 524.

³Hoffman. *Hygienische Rundschau*, 1905, xv, 1233.

⁴Pizzini. Quoted by Hoffman.

⁵Tavel. *Centralblatt für Bakteriologie, Erst. Abt.* xxiii, 1898, 538.

⁶Libman. Quoted by Buerger. *American Journal Medical Sciences*, 1905, Series, cxxx, 267.

the intestines and reported by Brewer (Table I a₃₀), Goodrich (Table I a₄₄), Willy Meyer (Table L b₁₉), Kammerer (Table I b₂₀) and Roe (Table I b₄₅). Four of them were for the removal of the appendix in the quiescent period, and followed the operation twice nine and once ten and eleven days respectively, while in the fifth colectomy was performed for the removal of a cancer of the splenic flexure.

Rather more difficult of explanation is the portal of entrance of the bacillus in a case reported by Warbasse (Table I a₃₆), in which tetanus appeared six days after the performance of supravaginal hysterectomy and double oöphorectomy through an abdominal incision.

That tetanus can readily follow unclean surgical procedure appears in a case reported by Mudd (Table I c₁₂) in which it was the sequel of an open operation for varicocele performed by a doctor connected with an advertising institution and admitted into St. Luke's Hospital, St. Louis, after the disease had become established.

In a series of three cases reported by Fournau as having occurred at the Goettingen klinik⁷ one followed a Bassini operation for the radical cure of hernia. This infection was attributed to a case of tetanus cared for on the preceding day. No case of tetanus having occurred in this klinik for seven years, the reporter states that they were thrown off their guard and proper precautions to avoid infection had not been taken.

The danger of the transmission of the disease in hospitals is not generally appreciated. In this country, as far as we are informed, the only hospital in which complete isolation from all other surgical patients is practised is the Pennsylvania, in Philadelphia, where all tetanus cases are transferred to the medical service for treatment.

Conditions of Infection.—The occurrence of idiopathic tetanus is most unlikely. It is essential for the production of the disease that the bacillus either in its vegetative or spore state, or its toxin, must gain entrance into the tissues

⁷ Fournau. Deutsche Medizinische Wochenschrift, 1904, 10.

of the body through some injury to the skin or mucous membrane. The disease is a true intoxication, and the tetanus toxin alone is capable of producing it. Yet tetanus toxin fed to animals is not absorbed as such through the uninjured digestive tract, but is either digested or passed out with the fæces unchanged.

Once having gained entrance into the tissues, the bacillus is capable of producing its toxin only under certain conditions.

Some years ago Vaillard⁸ and more recently Tarozzi⁹ showed that the spores of the tetanus bacillus when freed from the toxin before injection into the body did not produce the disease, unless other substances were also injected, or conditions created which would bring about necrosis in the tissues.

While necrosis is essential for infection, neither the incubation, the onset, nor the severity of the attack is strictly dependent upon the amount of visible destruction of tissue or suppuration which takes place. The explanation of this is that minute quantities of tetanus toxin have the most powerful poisonous effect, and but very slight development of the bacillus is required for the production of several fatal doses of the poison. Thus Vincent¹⁰ has recently shown that the subcutaneous injection of small amounts of solutions of quinine and its salts, which contained tetanus spores deprived of their toxin, brought on fatal attacks of tetanus. In these cases the determining factor appeared to be the slight necrosis induced by the quinine injected. He states that tetanus is a frequent sequel to subcutaneous quinine injection, but a rare development after the subcutaneous administration of morphine. The latter drug, he states, does not produce necrosis.

⁸ Vaillard. *Annales de l'Institut Pasteur*, 1892, 6.

⁹ Tarozzi. *Centralblatt für Bakteriologie Erst. Abt.* 1906, XL, Originole 305.

¹⁰ Vincent. *Annales de l'Institut Pasteur*, 1904, xviii, 748.

Another active factor in the determination of tetanus infection is the presence of aërobic bacteria in the injured area, and the symbiotic development of them and the tetanus bacilli. Thus von Hibler¹¹ has shown that mildly virulent tetanus bacilli can be enhanced in pathogenic power by coincident mixed infections; Garnier¹² that the injection of typhoid cultures together with tetanus toxin increased the toxic power of the latter, and Zanfroguini¹³ that the presence of the colon bacillus and the staphylococcus aureus had the same effect.

Distribution of the Tetanus Bacillus in the Body.— Ordinarily the tetanus bacillus is present in the body only at the site of injury. It has been shown, according to authors quoted by Tarozzi,⁹ in a few cases of tetanus in man that the bacillus was found at autopsy in the sciatic nerve, the spinal cord, the medulla oblongata, lymph nodes, cerebrospinal fluid, and spleen, and during life in the circulating blood. Tarozzi by experiment showed that spores injected into animals were found in a live state in the internal organs, especially in the liver, as late as three months afterwards.

Vincent¹⁴ found that if animals which had been injected with solutions containing spores freed from toxin were kept in incubators at high temperatures, that the bacteria were most likely to wander into the circulating blood and would develop and tetanic symptoms would be produced.

Of the sources of infection not yet mentioned is the injection of solutions containing gelatin for the purpose of controlling hæmorrhage. Two such cases are reported¹⁵ as having occurred at the klinik of Helferich in Kiel. In the first instance it was given subcutaneously into the thigh two hours before the performance of laryngectomy to prevent

¹¹V. Hibler. *Centralblatt für Bakteriologie*, Erst. Abt. Ref. xxxvii, 545.

¹²Garnier and Sabareau. *Archiv. de Med. Experiment*, 1904, 16, 557.

¹³Zanfroguini. *Centralblatt für Bakteriologie*, Erst. Abt. Ref., 1906, xxxvii, 650.

⁹Tarozzi. *Loc. cit.*

¹⁴Vincent. *Annales de l'Institut Pasteur*, 1904, xviii, 450.

¹⁵*Deutsche Zeitschrift f. Chirurgie*, October, 1901.

uncontrollable capillary hæmorrhage. This it accomplished. But tetanus appeared six days after, with evident septic disturbance in the thigh. The muscles of the back and lower extremities were particularly convulsed. Death followed promptly, despite the use of the antitetanic serum. The field of operation in the neck showed no evidence of infection.

In the second case it was used to control secondary hæmorrhage occurring from a subphrenic abscess. After a period of six days severe tetanus appeared, which was fatal in two days.

Period of Incubation.—All the factors mentioned, as determining the occurrence of tetanus, exercise a proportionate influence upon the period of incubation, the character of the onset, the course, and the termination of the disease.

The period of incubation may vary within wide limits. Rose and many others have reported incubation periods as short as twenty-four hours and even less. If what is now quite generally accepted as the path of the poison from the site of its production to the nerve centers is correct, then such cases as have been recorded with periods of incubation under three days must be accepted with considerable reserve.

And yet a case reported by Kuhn of Cassel at the *Versammlung Deutscher Naturforscher und Aerzte*,¹⁶ offers a new explanation of this group of cases. A boy, a bleeder, had been operated upon for the removal of adenoids from his nasopharynx. The hæmorrhage being uncontrollable, a gelatin injection was given him. At the site of injection gangrene promptly appeared and after twelve hours general tetanus was present, from which death speedily resulted. Schuckmann¹⁷ commenting on this case expresses the opinion that the gelatin injection must have contained a poisonous dose of toxin, the injection of which, rather than the bacillus, caused the death.

¹⁶ *Berliner Klinische Wochens.*, 1901, p. 1118.

¹⁷ *V. Schuckmann. Deutsche Med. Wochens.*, 1903, March 5.

While a short incubation period usually implies intensity of infection, Warbasse (Table I a38) reports the case of a patient 13 years of age, resulting from a punctured wound of the foot, from the penetration of a nail, with an incubation period of but four days. The treatment consisted in the injection of 20 c.c. of antitoxin subcutaneously. The case was one of general tetanus, yet terminated in recovery.

On the other hand in Table I appear seven cases in which the disease did not manifest itself until the nineteenth day in one, the twenty-first day in three, the twenty-fifth day in two and the twenty-sixth day in one. Four of these were treated with subcutaneous injection of the serum, two by intraspinal and one by deep intramuscular injection. All of the cases recovered except the last one. This patient, twenty-five days before, had received a punctured wound of the sole of his foot and entered Johns Hopkins Hospital on the first day of the disease. For a few days he seemed to improve under the serum treatment, and it was discontinued. Death occurred suddenly on the seventh day. This case must be considered as one in which the appearance of tetanus was delayed, but yet in which the infection was virulent when awakened into activity.

In Table II occur three cases with incubation periods of eighteen, nineteen, and twenty-two days respectively. One of them was so mild that recovery would have occurred under any treatment, and in another, the result of a burn, the general condition is stated to have been exceedingly bad and is held responsible for the death. The third recovered, having received 800 c.c. of antitoxic serum in the course of eight days.

It is interesting to note that in only one of these ten cases was a punctured wound responsible for the tetanus, most of them having been due to crushed or lacerated wounds.

The analysis of our tables furnishes some very suggestive facts upon this point. In them will be found 52 cases due to blank cartridge or gunshot wounds, presenting an

average incubation period of 7.3 days with a mortality of 76 per cent., and 51 punctured wounds with an average incubation period of 7.9 days, a mortality of 74.5 per cent., while in the 28 lacerated wounds tabulated, the incubation period was 11.8 days and the mortality 53.6 per cent.

We must now consider what occurs during the period which intervenes between the receipt of the injury and the appearance of the first tetanic manifestations.

The relation of toxin to the nervous system.—New light has been shed upon the pathology of tetanus by the researches of Meyer and Ransom¹⁸ and Marie and Morax.¹⁹ Their work has been reviewed so frequently that it is only necessary at this time to recall the main conclusions that have been reached.

The presence of tetanus toxin in the living body causes no symptoms, clinically appreciable, until it has been absorbed by the muscular terminations of the motor nerves, has passed along their axis-cylinders, and has reached the motor root-cells in the spinal cord. While the toxin is in the nerves, or in the spinal cord acting upon the spinal cells, it is effectually isolated from antitoxic substances present in the blood or lymph circulations. If, however, a nerve, or the spinal cord, be injured in such a manner as to expose the axis-cylinders or the nerve-cells to the toxin in the blood or lymph, the affinity of the toxin for such nerve element is soon manifested by awakening a tetanic condition in the part controlled by that nerve or the affected nerve-cells. Odier²⁰ claims that the toxin has a lytic effect on the out-runners of the motor end-plates, and that it has a somewhat similar effect upon the axis-cylinders of the nerves, pro-

¹⁸Meyer and Ransom. *Archiv. fur Experimentelle Pathologie und Pharmakologie*, 1903, 49, Heft 6.

¹⁹Marie and Morax. *Annales de l'Institut Pasteur*, 1902, xvi, No. 11, and 1903, xvii, No. 5.

²⁰Odier. *Archives de Médecine Experimentale et d'Anatomie Pathologique*, 1904, 16, 451.

portional to the amount and concentration of the toxin passing through them. In other words, it is apparently possible for the toxin to come in contact with the nerve elements for which it has a strong affinity at only one point, namely, at the termination of the motor-nerves in the muscles. The time taken for the toxin to be absorbed and to pass through the nerves represents the large part of the period of incubation. Courmont and Doyan²¹ have shown that the period of incubation in different animals is roughly proportionate to the distance between the termination of a nerve and its central nerve-cell. The early appearance of trismus, in natural infections, can be explained by the fact that the nerve supplying the muscles of mastication is a comparatively short one. Thus, the period of incubation is the net result of the length of nerve and the degree of concentration of toxin at the point of its absorption by the nerve terminals.

It is apparently established that the toxin produced at the portal of entry of the tetanus bacillus is absorbed by the muscular terminations of the motor-nerves of the part as well as the lymphatics, is transported directly through the axis-cylinders of the nerves to the cord, and also by an indirect route through the lymphatics to the blood and thence by way of other nerve fibres to the spinal cord.

Tetanus antitoxin.—There is not the slightest question of the power of tetanus antitoxin to neutralize free tetanus toxin outside the body or in the circulating blood or lymph channels. To what extent it can release the organ-bound toxin has not yet been determined. There is no experimental nor clinical evidence that it has any effect on the toxin passing along the axis-cylinders of the nerves, even if it is present in large amounts in the circulating blood.

The histologic arrangement of the parts prevents the toxin present in the blood and lymph from acting directly upon the sensitive nerve-cells, despite its apparent pro-

²¹Courmont and Doyan. Quoted by Marie and Morax.

pinquity. This same condition affords an effective barrier, which likewise prevents the neutralization of the toxin by the antitoxin when once the latter has passed into the axis-cylinders and has reached the nerve-cells.

The absence of a standard method of expressing the antitoxic strength of tetanus antitoxin renders it impossible to properly estimate the exact amount administered in a given case and materially interferes with our reaching definite conclusions in this regard in studying the accompanying tables.

A committee has been appointed by the Society of American Bacteriologists, to whom this matter has been referred, and we shall have, therefore, before long a standard serum of known strength.

While in the cases reported in this paper an effort has been made to specify the names of the producers of the antitoxin used, no comparison of the relative merits of the different varieties has been attempted.

A review of our tables will indicate that in many instances what might be considered large doses have been freely administered, and aside from the occasional occurrence of urticaria or dermatitis no ill effects have been noted.

Preventive Injections.—From what has been said, it is quite evident that antitoxin to be of the greatest service must be administered before the motor-nerves have absorbed any toxin. The serum should, therefore, be administered as soon after the infliction of the injury as possible, and should be given to every person who has sustained an injury in which dirt, manure or foreign substance could possibly have been carried into the wound. Injuries received by persons whose labor brings them in contact with the soil, or whose work is among domestic animals, should be regarded as suspicious and should receive the tetanus antitoxin as a part of the routine treatment.

These preventive injections should, however, be given intelligently, and the size of the injection, the site chosen,

and its repetition, should be regulated by the character and location of the injury.

Injuries involving the nerve-trunks should be treated with antitoxin locally as well as subcutaneously, in order to avoid the direct absorption of toxin by such injured nerves. For this purpose either liquid or dried antitoxin is suitable.

In injuries considerably contaminated by dirt the prophylactic dose given at the first dressing should be repeated on the third and fifth days, and again from the fifteenth to the twentieth day if suppuration still continues. The passive immunity conferred by a single prophylactic injection of tetanus antitoxin undoubtedly is of no longer duration than is that given by a similar injection of diphtheria antitoxin. This on the average is from three to four weeks. Yet the protection may be but for a few days. The virulence of the toxin may be maintained, although the outbreak of tetanus is deferred. As evidence of this, Sejour²² reports a fatal case of only twenty-four hours' duration, the onset of which occurred twenty-two days after the injection of a prophylactic dose in a case of compound fracture.

Suter²³ reports a case of tetanus occurring forty-seven days after the use of one prophylactic dose. He has collected eleven other cases from literature.

We are able to add six cases to this list from reports made to us personally. They are, briefly, as follows:

CASE I.—Age 8; reported by Dr. A. J. Ochsner; treated at St. Mary's Hospital, Chicago. Compound comminuted fracture of the left leg. One injection of 10 c.c. antitoxin of French make given sixteen hours after injury. No unfavorable symptoms until the twelfth day, when trismus and opisthotonos appeared, but which subsided after forty-eight hours; the patient then making an uneventful recovery.

²²Sejour. *Gazette des Hopitaux*, 1905, lxxviii, 606.

²³Suter. *Archiv fur klinische Chirurgie*, 1904, lxxx, 113.

Reference *Centralblatt fur Bakteriologie Erst. Abt. Referate*, 1906, xxxvii, 675.

CASE II.—Reported by Dr. Leonard Freeman, of Denver, Colo., the injury being a punctured wound of the foot due to a nail; 10 c.c. were given several hours after the injury. Local irritation and a pronounced general erythema lasting several days occurred. Six days later there was mild trismus, with soreness of the shoulders and legs. Recovery.

CASE III.—Occurred at the Pennsylvania Hospital, Philadelphia, in the service of Dr. James Tyson. The patient, forty-eight years of age, received a punctured wound in the palm of the right hand caused by a rusty nail. Four days later 30 c.c. of antitoxin were injected about the wound. On the eighth day there was pain and stiffness of the corresponding arm and forearm, associated with painful mastication. This disappeared in the course of three days.

CASE IV.—Dr. J. H. Branan, Albany, N. Y., cared for a boy fourteen years old, who received on July 4, 1905, a lacerated wound of the hand from the premature explosion of a cannon. Tetanus bacilli were found in a smear taken from the middle finger. He received an intramuscular injection of 10 c.c., July 7, and a like injection July 15. Between these latter dates he suffered from stiffness of the jaws and of the neck muscles, which cleared up and the patient recovered.

CASE V.—Dr. L. L. McArthur, of Chicago, contributes the fifth to this list of cases. The patient was injured in a street-car accident, having been rolled, crushed, and then dragged a distance before being rescued. A compound comminuted fracture of the skull resulted, dirt being ground into the wound. Both upper and lower extremities had open comminuted fractures. The injured parts received thorough surgical attention, and were made clean. On the first, second and third days she received 30 c.c. of Behring antitoxin. On the eleventh day, the wounds having done well, the scalp wound was drawn together by suture. Two days later there was a rise of temperature to 102° , and on the following day, the fourteenth after the receipt of the injury, there was trismus so that the jaws could be separated only three-eighth of an inch, and stiffness of the neck; 20 c.c. of antitoxic serum were administered. The next day an injection of 30 c.c. was given. From this time on there was a disappearance of the tetanic manifestations.

CASE VI.—Dr. James Bell (Table I b47) reports the case of a patient, aged 9, treated in the Royal Victoria Hospital, Montreal. He had sustained a contused and lacerated wound of the skin over the tibia and was given 5 c.c. of antitetanic serum as a prophylactic injection on the day following the injury. Although tetanus did not appear until the forty-seventh day thereafter, it was so virulent as to cause death in five days.

It is to be noted, however, in all of these cases with the exception of the sixth, that the toxin was so modified in its intensity that the tetanic symptoms were of short duration and in each instance the patient recovered. In the

latter, however, although the outbreak was delayed, the virulence of the toxin persisted.

Letters received from members of this association indicate that it is the practice in the hospitals of New York, Chicago, Baltimore, Cincinnati, Cleveland, Boston, Montreal, Brooklyn and Albany to use the antitoxin prophylactically and to inject it usually subcutaneously, although in Cleveland it is given into the spinal canal, in all of the cases in which it is believed that there is danger of the development of tetanus, and with the exceptions mentioned the disease has never appeared after such injection.

At the fifteenth congress of French surgeons the treatment of tetanus was most exhaustively considered.²⁴ The subject was presented by M. Vallas, of Lyons. Speaking of the preventive power of the injections of the antitoxic serum, he is most emphatic in his decision that it is an agent of such positive value that with its constant use tetanus would cease to exist altogether.

No one will pretend to claim that the prophylactic injections are to take the place of the efforts to be made in each instance to render the parts thoroughly clean at the primary dressing, or to remove all possible infected tissues.

In many hospitals reliance is placed upon these procedures, and indeed this has been the policy in the hospital with which one of us is connected. In this hospital several hundred cases of wounds of such character as might have been followed by tetanus have been thus treated, and yet there has been no occurrence of that disease since 1899.

We have received the report of a number of cases treated at various of the large hospitals of the country, where excision of the infected area was practised when possible, and thorough cleansing and disinfection where this could not be done and where no serum has been used, yet tetanus has

²⁴Association Francaise de Chirurgie, 1903.

not occurred. This subject has also been considered by Bain²⁵ and Richardson.²⁶

In the cases reported by the latter, however, the use of the antitoxic serum was combined with thorough surgical attention.

This combination of procedures is the one which should be pursued. The prophylactic injections should be given directly into the muscles, as this method affords more rapid absorption than when carried only into subcutaneous tissues as has been shown by Meltzer and Auer.²⁷ The injection of antitoxin into adipose tissue, as is frequently done, is probably a waste of effort and material.

The necessity of giving these injections early, so that they may indeed be protective, is made exceedingly clear when we realize that if the necessary time elapses after the introduction of the bacilli for the development of a sufficient amount of toxin, not even amputation will prevent the appearance of tetanus.

Two cases in Table I illustrate this point. In the first (Table I b23) a man sustained a compound fracture of the leg April 24, 1902, because of which the leg was amputated at the New York Hospital April 30th. Despite this, tetanus appeared May 3, and death occurred the next day.

In the second (Table I a52) a man run over by an electric car December 26, 1905, was brought three and one-half hours later into the Massachusetts General Hospital. The wound became septic, and amputation was performed December 30th. The next day the temperature rose to 105, the neck became rigid and dysphagia appeared. Despite antitoxin, then given subcutaneously, he died January 3, 1906.

Local Tetanus.—Before considering the therapeutic use of tetanus antitoxin, there remain some points to be emphasized which have a bearing thereon.

²⁵Bain. *ANNALS OF SURGERY*, 1903, Vol. 37, 399.

²⁶Boston Medical and Surgical Journal, 1905, Vol. 152, 493.

²⁷Meltzer and Auer. *Journal of Experimental Medicine*, 1905, 7, 59.

Tetanus provoked in animals as a result of experimentation exhibits almost without exception as its earliest manifestations those of a purely local character and which are at first restricted to the neighborhood of the inoculation. This is now understood to be due to the absorption of the toxin by the motor-nerve of the part. The conditions favoring the local appearance of tetanus are a short motor-nerve as in head injuries; an injury to a nerve-trunk permitting the rapid absorption of a large amount of toxin; the production of a meager amount of toxin or the presence of something which prevents the admission of a large amount of toxin into the circulation.

Axhausen²⁸ reports eleven cases in man with but a single death in which distinct local tetanic symptoms preceded the usual manifestations. After studying these cases he concluded that they had a long incubation period averaging twenty days, that the symptoms were slow to develop and likewise to decline. In Table I will be found ten cases in which local manifestations in the part injured preceded the other evidences of tetanus.²⁹ Three of them resulted from head or face injuries, all recovering; two were blank cartridge wounds of the hand, one recovering; one a lacerated hand; two gunshot wounds of the thigh; one due to an abrasion of the shin; and one to a penetrating wound of the foot. The two latter recovered. The average incubation period of this group was only 9.2 days, however. Six of them recovered, showing a mortality of only forty per cent. Our cases, therefore, verify in the main the statements of Axhausen, although the mortality was considerably higher.

Classification of Cases.—Recognizing the fact as previously stated that the length of the incubation period is as a rule a good index of the virulence of the infection, for the purpose of estimating the value of the serum treatment we

²⁸Axhausen. *Deutsche Zeitschrift für Chirurgie*, 1905, 78, 265.

²⁹Table I a, Cases 16, 17, 24, 28, 42, 45. Table I b, 7, 21. Table I c, 8. Table I d, 2.

have divided the cases herewith submitted into two classes and shall speak of those as acute in which the incubation period was of less than ten days' duration, and of those as subacute when it was ten days or longer.

Believing that it is but natural that men would as a rule be more apt to publish their successes than their failures, we have not attempted to collect from literature the cases of tetanus which have been subjected to serum treatment. Two tables, however, are presented. The first represents the experiences gathered from many of the large hospitals of the United States. It is believed that as the table includes all of the cases treated at these institutions, and in a few instances in the private practice of their surgeons, a truer estimate of the real worth of the antitoxic serum could thus be obtained. The second covers all of the cases treated in New York State in which the State Department of Health furnished antitoxin. The data for this group of cases are furnished by Dr. Pease, one of the writers of this paper, who is the director of the antitoxin laboratory of this state.

In Table I there are 144 cases, in No. II 59, placing at our command 203 cases. Of those in Table I, 66 were treated by subcutaneous injection; 48 by injection of the serum into various structures; 12 by intraspinal; 16 by intramuscular; one by intracerebral, and one by intravenous injection.

Of the 59 cases in Table II, 42 were treated subcutaneously; 16 by injection into different tissues, and 1 by intracerebral injection.

In Table I there were 93 acute cases, the termination being known in 91. Of these 78 died, a mortality of 85.7 per cent. The number of subacute cases in this table is 44. The final result is given in 43. There were 15 deaths, a mortality of 34.9 per cent. In six the incubation period is not mentioned.

In Table II the termination was given in 36 acute cases; 29 died, mortality 80.6 per cent. Of 21 subacute cases in

which the result is given there were 11 deaths, a mortality of 52.4 per cent.

The mortality attending the various methods of administering the antitoxin shows the following in Table I:

Of 66 cases treated by subcutaneous injections, the incubation period is not mentioned in one case. Of the remaining 65, 47 were acute cases, the termination being known in 46. Of these 38 died, mortality 82.6 per cent. 18 were subacute, of which but four died, mortality 22.2 per cent.

In 48 cases treated by a combination of either subcutaneous, intraneural, intraspinal, intravenous or intracranial injections, the result is mentioned in 47. Of these 30 were acute, the termination being known in 29; 27 dying, a mortality of 93.1 per cent; 14 were subacute cases, of whom 7 died, mortality 50 per cent.

By intraspinal injection 12 were treated, in one the incubation period not being stated; seven were acute cases, 4 dying, mortality 57.1 per cent. In three subacute cases, in which the result was known, all recovered. Of 16 cases treated by intramuscular injection, in one the incubation period is not given. Of the remaining 15, 7 were acute, all dying; mortality 100 per cent. Of the remaining 8 subacute cases, 4 died; mortality 50 per cent.

In Table II a study of the cases results as follows: By subcutaneous injection 42 were treated; the incubation period was known in 40, and of this number 24 were acute, of whom 19 died; mortality 79.2 per cent. Of the 16 subacute cases thus treated, 7 died; mortality 43.8 per cent.

Sixteen were treated by the injection of the antitoxin into the several structures mentioned in a previous paragraph. Eleven were acute cases, 9 dying; mortality 81.8 per cent.; while of 5 subacute cases four died, a mortality of 80 per cent.

In each table there is recorded a single case treated by intracerebral injection alone. Both patients died.

In Table I there appears one acute case treated by intravenous injection. This patient died.

The tables were carefully analyzed for the purpose of studying the degree of virulence of the cases treated by the different methods, and it appears that a larger percentage of cases with a short period of incubation, rapid progress and an early death, were treated by subcutaneous injection than by any other method.

As to the amount of antitoxin injected, in but 20 cases were more than 500 c.c. administered. These cases had an average incubation period of 10.8 days ; 15 recovered and 5 died, a mortality of 25 per cent. Five of the 15 recovering had short periods of incubation. The treatment was begun in these cases on an average 3.3 days after the appearance of tetanic symptoms, and the average length of its continuance was 7.4 days. The largest amount of antitoxin given a single patient was 1495 c.c. Of the 20 cases, seven are found in Table I, with two deaths, mortality 28.6 per cent.; and 13, with three deaths, mortality 23 per cent., in Table II.

It is apparent that the amount of antitoxin administered to these patients is not the only factor to be considered in their recovery, for as a group they belong to the subacute class.

It should be stated that in most of the cases included in our tables medicinal treatment was given in addition to the serum. Occasionally it will be noted that the reporter has commented to the effect that he attributes in a given case quite as much to the drugs as the serum.

Reference might here be made to the paper by Anders and Morgan.³⁰ It is based upon 252 cases, in 115 of which the antitoxic serum was used. But the details of its use are so meagerly stated that we are not able to estimate its worth in the cases quoted. A few of these cases appear in our Table I. However, their conclusions as to the value of

³⁰Anders and Morgan. *Journal of the American Med. Assn.*, July 29, 1905.

serum therapy do not differ materially from those we are compelled to reach.

Treatment of Tetanus.—From the facts here presented, it is apparent that after tetanus is fully established serum therapy, however administered, promises but little as a curative agent.

A word as to the special methods of injection. The intracerebral method first practised with apparent success by Roux and Borrel³¹ experimentally in animals, was received for a short time with favor by the profession. The results obtained by it were not particularly encouraging. The two cases reported in our tables as having been treated by intracerebral injection alone, both died. Table I b contains a list of 11 cases treated by a combination of subcutaneous and intracranial injections. Four of these cases received also intravenous injections. Of the 11 thus treated, but one recovered, a mortality of 91 per cent.

The method has nothing particularly to commend itself as a means of reaching either the free toxin or that fixed to cells of the nervous system. Moreover, it is not devoid of danger, as in the case reported by Gibb³² first as cured and later³³ as having died of cerebral abscess. At the autopsy each frontal lobe contained an abscess cavity, the left one communicating with the left lateral ventricle, and through the great transverse fissure with the cerebellar fossæ. Every effort was made, we are assured, to perform the operation aseptically. The serum was believed to have been sterile. The suppurating condition was attributed to the frequent repetition of the injection.

The injection of tetanus antitoxin into the subdural space by means of lumbar puncture was devised by Blumenthal and Jacob.³⁴ This method has been used extensively.

³¹Roux and Borrel. *Annales d'Institut*, 1898, 12, 225.

³²Wm. F. Gibb. *British Med. Journal*, April 15, 1899.

³³Wm. F. Gibb. *British Med. Journal*, July 1, 1899.

³⁴Blumenthal and Jacob, *Berliner klinische Wochenschrift*, 1898, 32, 1079.

Without carefully analyzing the cases in our table I c, we might be led to estimate the value of this method above its real worth. It should be noted, however, that two of the cases had an incubation period of twenty-one and twenty-six days respectively, both recovering, and that in the four cases reported by Lockett, all of whom recovered, the reporter lays greater stress upon the withdrawal of the cerebrospinal fluid than upon the injection of the antitoxin. This was done because the claim is made that it is rich in toxin and that by its withdrawal a large amount of toxin is removed. That this assumption is unwarranted appears from the investigations of Jacob and Blumenthal,³⁵ Meyer and Ransom,¹⁸ Millian and Legros.³⁶ Lockett withdrew 161 m., 605 m., 1556 m., and 3610 m., of spinal fluid in these cases respectively. Moreover, it will be noted that in two of his cases local tetanus preceded the general manifestations, a condition which we have shown indicates a mild attack of tetanus; while a third case (No. 9 of this table) it appears to us cannot be absolutely regarded as one of tetanus, and his fourth case is to be classed as subacute, judged by the incubation period.

The injection of antitoxin into the subdural space offers but little prospect of reaching the affected nerve-cells because of the protection offered by the pia mater. It has been demonstrated that even the tetanus toxin injected into the subarachnoid space does not reach the nerve-cells directly.

For this reason it has been suggested that the antitoxin be carried more deeply, and that it be introduced either into the cord or the cauda equina. Rogers³⁷ has practised this method in connection with intraneural and intravenous injections in six cases, with three recoveries. A seventh case included in his report occurred in a patient who punc-

³⁵ Jacob and Blumenthal. Berlin, Kl. Wochensch., 1898, 49. -

¹⁸ Meyer and Ransom. *Loc. cit.*

³⁶ Milian and Legros. Soc. de Biol., March, 1901.

³⁷ Rogers. Journal of Amer. Med., Apl., July 1, 1905.

tured his left wrist with a hook July 2, 1904, and the palm of his right hand with the same hook July 10, 1904. He was not admitted into the hospital until August 10, 1904, so that there was an incubation period of not less than thirty-one and it might have been as long as thirty-nine days. This patient received a single injection into the nerve-trunks of each upper extremity of five and ten minims respectively and 10 c.c. subcutaneously in the neighborhood of the wound in each extremity. It seems to us that this case should be considered apart from the others. Of the other three recoveries one had an incubation period of sixteen days and ran a mild course, while the other two were acute cases and the results obtained were most gratifying.

The three fatal cases were all due to crushing wounds of the extremities; two having incubation periods of ten and eleven days respectively, and one of six days.

Meyer and Ransom¹⁸ recommended that attempts be made to neutralize the toxin present in the large nerve-trunks by the injection of antitoxin into them, and reported one case in which an attack of local tetanus was relieved by the injection of antitoxin into the motor-nerves controlling the tetanized region.

Kuster³⁸ reported to the German Surgical Congress at its session in 1905, a similar case of localized tetanus which was relieved by injections of the proper nerves. In reviewing this case he expressed the opinion that intraneural injections could be of benefit only while tetanus is localized. Kocher and other German surgeons in the course of the discussion endorsed this view, agreeing that only the toxin present in the injected nerve could be thus neutralized. It is even doubtful whether it is possible to neutralize any considerable portion of the toxin in a given nerve by intraneural injections. Fletcher³⁹ has shown very definitely that it is

¹⁸Meyer and Ransom. *Loc. cit.*

³⁸Kuster. Abstract of proceedings of German Surgical Congress, 1905.

³⁹Fletcher. *Brain*, 1903, 26, 383.

not an easy matter to inject a nerve-trunk so that any large number of its axis-cylinders become exposed to the fluid injected. In several of his experiments in which toxin was injected into nerves the poison passed directly into the lymph-spaces of the endoneurium and did not reach any of the axis-cylinders, for no tetanus resulted. Only when he injured a considerable number of the axis-cylinders of the nerve by his injection did he succeed in producing absorption of the toxin by the axones.

Theoretically, if antitoxin comes in contact with a marked number of the axis-cylinders of an injected nerve-trunk, the symptoms in the region controlled by that nerve should cease very shortly and not recur. This is what took place in Kuester's case, for there occurred a subsequent painful myositis of the muscles supplied by the injected nerves. Intraneural injections no doubt interrupt the current through the axis-cylinders because of the mechanical pressure they produce, and thus prevent the absorption of the toxin for the time being.

But a word is necessary, in conclusion, to summarize the results of serum therapy in the light of the laboratory studies referred to and the clinical experiences herewith submitted. As a prophylactic measure it merits our fullest confidence, but as a therapeutic agent after tetanus is fully established we are forced to admit that as yet no method has been discovered whereby it can be administered so as to reach effectively the toxin not free in the blood or lymph.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY SUBCUTANEOUS INJECTION.

CASE 1.—KEEFE, Rhode Island Hospital. Age 23. Punctured wound of foot by rusty nail. Tetanus bacilli found. Period of incubation, 5 days; trismus—rigidity of cervical muscles; general convulsions 3 days later; treatment began second day; continued 2 days. Subcutaneous injection of antitoxic serum, first day: 2 injections, 30 c.c. each, = 60 c.c.; second day: 5 injections, 60 c.c. each, = 300 c.c. Total amount injected, 360 c.c. Death on third day after admission.

CASE 2.—HERSEY, Rhode Island Hospital. Age 51. Small punctured wound of scalp; rusty nail. Tetanus bacilli found. Period of incubation, 7 days; trismus; general convulsions next morning; treatment began first day; continued 1 day. Subcutaneous injection of antitoxic serum, one injection,

40 c.c. Total amount injected, 40 c.c. Sudden convulsion next morning and death.

CASE 3.—MUNRO, Rhode Island Hospital. Age 10. Blank cartridge wound of hand; 4th of July accident. Period of incubation, 8 days; trismus; stiffness cervical and spinal muscles; treatment began third day; continued 1 day. Subcutaneous injection of antitoxic serum, in several injections, 300 c.c. Total amount injected, 300 c.c. Course and termination unknown.

CASE 4.—HERSEY, Rhode Island Hospital. Age 44. Two fingers crushed by falling log. Period of incubation, 21 days; moderate trismus and rigidity of neck, slight opisthotonos; general convulsions frequent but slight; treatment began first day; continued 4 days. Subcutaneous injection of antitoxic serum, 8 injections daily, 40 c.c. Total amount injected, 1280 c.c. Dismissed cured after 20 days.

CASE 5.—GODDING, Rhode Island Hospital. Age 59. Burn of both feet, second degree. Tetanus bacilli found. Period of incubation, 9 days; delirium, trismus; treatment began second day; continued 1 day. Subcutaneous injection of antitoxic serum, 2 injections, 20 c.c. each. Total amount injected, 40 c.c. Death one-half hour after second injection.

CASE 6.—MUNRO, Rhode Island Hospital. Age 55. Right thumb crushed working in lumber yard. Period of incubation, 5 days; trismus; general convulsions 2 days later; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 1 injection, 20 c.c. Total amount injected, 20 c.c. Death three and a half hours later.

CASE 7.—MITCHELL, Rhode Island Hospital. Age 50. Wound of bridge of nose; fall on stairs. Period of incubation, 12 days; 7 days after injury slight twitching of jaw muscles—disappeared; trismus twelfth day; treatment began third day; continued 10 days. Subcutaneous injection of antitoxic serum, first day, 1 injection, 40 c.c.; second to ninth days, every 6 hours, 20 c.c. Total amount injected, 760 c.c. Left hospital on 25th day; weak and with slight trismus persisting.

CASE 8.—ROSWELL PARK; private patient. Age 21. Toy pistol; second finger left hand. No tetanus bacilli found. Period of incubation, 10 to 11 days; trismus; soreness muscles back of neck; dysphagia; treatment began second day; continued about 15 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 3 injections, 10 c.c.=30 c.c.; afterwards 1 to 2 injections, 10 c.c. each until 27 had been given. Total amount injected, 270 c.c. Recovered.

CASE 9.—M. W. RAYNOR, Newark City Hospital, Newark, N. J. Age 11. Punctured wound of foot; rusty nail. Tetanus bacilli found. Period of incubation, 8 days; trismus, extreme opisthotonos, T. = 101°–102.5°, dysphagia, general pain, retained urine, delirium; general convulsions; treatment began on first day; continued 12 days. P. D. & Co.'s and Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, first day, one injection, 40 c.c.; second to seventh days, every 4 hours, 30 c.c.; next 2½ days, every 6 hours, 20 c.c.; last 2 days, every 8 hours, 10 c.c. Total amount injected, 1380 c.c. Recovered.

CASE 10.—GEO. TULLY VAUGHAN, Emergency Hospital, Washington, D. C. Age 27. Punctured wound left foot; rusty nail. Period of incubation, 7 days; trismus; stiffness of neck, cramps in abdomen, weak mucous râles; P. = 90–120; T. = 99°–102°; general convulsions; treatment began fourth day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 15 injections of 20 c.c. each in 4 days. Total amount injected, 300 c.c. Pneumonia on sixth day and death on eighth day.

CASE 11.—GEO. TULLY VAUGHAN, Emergency Hospital, Washington, D. C. Age 59. Compound comminuted fracture left leg; wound suppurated. Period of incubation, 11 days; trismus, dysphagia; treatment began on second day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 7 injections in 2 days, 20 c.c. each. Total amount injected, 140 c.c. Death in severe general convulsions on second day.

CASE 13.—GEO. TULLY VAUGHAN, Emergency Hospital, Washington, D. C. Age 33. Punctured wound sole of foot; nail. Period of incubation, 5 days; trismus, rigidity of abdomen and back; general convulsions; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections; 25 c.c. every 3 hours. Total amount injected, 200 c.c. Death 24 to 36 hours after appearance of symptoms.

CASE 13.—GEO. TULLY VAUGHAN; private. Age 25. Calf right leg impaled on rusty hook. Period of incubation, 7 days; complete trismus, next day cramps in abdomen; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections; 25 c.c. q. 3 hours. Total amount injected, 200 c.c. Death on third day.

CASE 14.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 16. While working in livery barn stepped on nail. Puncture wound of right foot. Period of incubation, 7 days; felt ill on seventh day; pronounced tetanic convulsions ninth day after injury; treatment began on fourth day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 18 injections; 10 c.c. q. 4 hours. Total amount injected, 180 c.c. Leg amputated; death on sixth day.

CASE 15.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 15. Contused wound from explosion of cannon cracker, 4th of July. Tetanus bacilli found. Period of incubation, 6 days; fifth day pain in region of esophagus; sixth day, trismus; general convulsions; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections; 10 c.c. q. 4 hours. Total amount injected, 60 c.c. Arm amputated; death on third day.

CASE 16.—LEONARD FREEMAN, St. Joseph's Hospital, Denver, Col. Age 55. Superficial excoriation of skin. No tetanus bacilli found. Period of incubation, 21 days; cramps in leg; trismus; right arm cramped; T. = 99°–100°; treatment began on third day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 15 c.c., repeated in 6 hours, and twice thereafter at 8 hour intervals. Total amount injected, 60 c.c. Recovery; attributed to medicines given and not to serum.

CASE 17.—PATCH, Montreal General Hospital. Age 27. Lacerated wound, bridge of nose, abrasion of face. No tetanus bacilli found. Period of incubation, 6 days; fourth day—twitching, both sides of face, stiffness of eyelids; fifth day, worse; sixth day, trismus; no stiffness of neck muscles, superficial reflexes normal; (entered hospital this day); T. = 102°–104°; later stiffness of neck and back; some opisthotonos; treatment began on third day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first injection, 20 c.c.; afterwards every 6 hours—27 injections. Total amount injected, 300 c.c. At first grew worse, then gradual improvement and ultimate recovery.

CASE 18.—JOHN C. MUNRO, Boston; private. Age 19. Lacerated finger; crushed by door. No tetanus bacilli found. Period of incubation, 9 days; ninth day, sore throat, headache and dysphagia; eleventh day, trismus, and later (same day) opisthotonos; treatment began on second day; continued 2 days. Subcutaneous injection of antitoxic serum given by attending physician; amount not known. Death.

CASE 19.—F. E. BUNTS, Cleveland; private. Age 10. Lacerated right eyebrow and lid. Fall from street car—dirt ground in. No tetanus bacilli found. Period of incubation, 9 days; ninth day, moderate degree of trismus; tenth day, swallowing water produced violent spasm and opisthotonos; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours, 6 injections. Total amount injected, 60 c.c. Death on third day.

CASE 20.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 18. Blank cartridge wound of hand. Tetanus bacilli found. Period of incubation, 7 days; painful spasms of face, neck, back, and extremities; hypersensitive; treatment began first day; continued 36 hours. P. D. & Co.'s antitoxin used.

Subcutaneous injection of antitoxic serum, 7 injections; 10 c.c. q. 4 hours. Total amount injected, 70 c.c. Death after 36 hours.

CASE 21.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 12. Blank cartridge wound of hand. Part of wad still in hand on admission. No tetanus bacilli found. Period of incubation, 8 days; muscles of lower jaw, face, neck and abdomen rigid on admission; general convulsions; treatment began on second day; continued 6 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 injections, 10 c.c. q. 6 hours for 5 days. Total amount injected, 200 c.c. Death on seventh day.

CASE 22.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 13. Blank cartridge, left hand. Opened, cauterized, packed, July 4th. No tetanus bacilli found. Period of incubation, 7 days; neck stiff; throat felt queer; not marked on admission; treatment began on first day; continued 5 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 18 injections; 10 c.c. q. 6 hours for 5 days. Total amount injected, 180 c.c. Death on fifth day.

CASE 23.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 8. Blank cartridge wound of scrotum. Admitted on seventh day. No tetanus bacilli found. Period of incubation, 7 days; head retracted; trismus; general convulsions; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, single injection, 5 c.c. Total amount, 5 c.c. Death following morning, 2 A.M.

CASE 24.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 8. Blank cartridge wound palm of right hand. No tetanus bacilli found. Period of incubation, 7 days; slight contractions fingers injured hand; characteristic cry at intervals; next day head retracted; slight trismus; treatment began first day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections, 10 c.c. q. 6 hours. Total amount injected, 80 c.c. Death on third day.

CASE 25.—ED. H. OCHSNER, Augustana Hospital, Chicago. Age 12. Gunshot wound through hypothenar eminence left hand. No tetanus bacilli found. Period of incubation, 13 days; moderate degree trismus and opisthotonos; treatment began first day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. at 6 and 11 P.M. Next day 8 A.M., 3 P.M., 11.30 P.M., and 10 A.M. following day. Total amount injected, 60 c.c. Gradual recovery.

CASE 26.—EMMET RIXFORD, Lane Hospital, San Francisco. Age 35. Punctured wound of foot. Patient farm hand. Nail passed through shoe. No tetanus bacilli found. Period of incubation, 12 days; facial contortion first, then mild trismus and spasm of trapezius, neck and abdomen; treatment began eleventh day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 7 injections q. 10 c.c. Total amount injected, 70 c.c. Chloral and bromides also used. Recovery in 27 days.

CASE 27.—EMMET RIXFORD, Lane Hospital, San Francisco. Age 14. Lacerated wound of leg opening knee; compound fracture fibula. Head of bone covered with manure. No tetanus bacilli found. Period of incubation, 7 days; violent spasms including respiratory tract—opisthotonos; general convulsions; treatment began second day; continued 3 days. P. D. & Co.'s and Pasteur Institute antitoxin used. Subcutaneous injection of antitoxic serum, second day, 10 c.c.; third day, 20 c.c.; fourth day, 10 c.c. Total amount injected, 40 c.c. Death on fourth day.

CASE 28.—EMMET RIXFORD, Lane Hospital, San Francisco. Age 50. Perforating wound of lower lip. No tetanus bacilli found. Period of incubation, 7 days; mild—limited to face and neck; so mild that diagnosis questioned; no general convulsions; treatment began second day; continued 6 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, for 3 days q. 6 hours, and following 6 days q. 12 hours, 10 c.c. at each injection. Total amount injected, 180 c.c. Sodium bromide also given. Marked erythema. Recovery.

CASE 29.—GEO. E. BREWER, Roosevelt Hospital, New York. Lacerated wound of posterior and inner right arm; caught in machinery cogs. No tetanus bacilli found. Period of incubation, 19 days; mild trismus; no dysphagia; opisthotonos 2 days later following incision; treatment began second day; continued 10 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, first injection 10 c.c. into abdominal muscles, then q. 6 hours for 7 days, 10 c.c. On eighth and ninth days 2 injections 10 c.c. and on tenth day 1. Total amount injected, 340 c.c. Gradual improvement. Recovery in 47 days.

CASE 30.—GEO. E. BREWER, Roosevelt Hospital, New York. Age 28. Elliptical incision, site of appendectomy wound 5 years old. Incision for ventral hernia. No tetanus bacilli found. Period of incubation, 11 days; eleventh day, trismus; twelfth day, rigidity of arms and neck; very weak; later same day total rigidity; treatment began first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 4 injections, 15 c.c. q. 4 hours into abdomen. Total amount injected, 60 c.c. Death on third day.

CASE 31.—B. F. CURTISS, Bellevue Hospital, New York. Age 43. Compound comminuted gunshot wound of anterior side of foot. No tetanus bacilli found. Period of incubation, 7 days; stiffness lower jaw, next day almost complete trismus, by night stiffness of back; general convulsions; third day very severe; controlled by chloroform; treatment began first day; continued 3 days. Subcutaneous injection of antitoxic serum, first day, at 4 P.M., 9 P.M. and 12 P.M., 20 c.c.; second day, 6 injections q. 20 c.c.; third day, 20 c.c. q. 4 hours. Total amount injected, 300 c.c. Death on third day.

CASE 32.—H. B. WILLIAMS, New York Hospital. Age 14. Blank cartridge wound of hand, July 4th, 1904. Tetanus bacilli found. Period of incubation, 9 days; mild at first, rapidly becoming severe; general convulsions; treatment began second day; continued 6 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, second day, 6 P.M., 10 c.c., 9 P.M., 15 c.c., 12 P.M., 15 c.c.; third day, 6 A.M., 10 c.c., 12 M., 40 c.c.; fourth day, 40 c.c.; sixth day, 2 injections of 30 c.c.; seventh day, 30 c.c. Total amount injected, 220 c.c. Death; for 36 hours before death no convulsions—just before death opisthotonos and severe spasm.

CASE 33.—H. B. WILLIAMS, New York Hospital. Age 38. Hand crushed while working in streets. No tetanus bacilli found. Period of incubation, 3 days; mild at first, then very severe; general convulsions; treatment began second day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. at 10 A.M., 12:30 P.M., and 10 P.M. Total amount injected, 60 c.c. Death on second day.

CASE 34.—H. B. WILLIAMS, New York Hospital. Age 13. Punctured wound of foot. No tetanus bacilli found. Period of incubation, 9 days; trismus, retraction and stiffness of neck; treatment began on eighth day; continued 6 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, eighth day, 25 c.c.; ninth, 20 c.c.; tenth, 25 c.c.; eleventh, 20 c.c., 25 c.c.; twelfth, 20 c.c.; thirteenth, 20 c.c. Total amount injected, 155 c.c. Gradual improvement; discharged well after 31 days' sickness (27 days after admission).

CASE 35.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 8. Blank cartridge wound of hand. No tetanus bacilli found. Period of incubation, 6 days; trismus and opisthotonos; $T = 104^{\circ}$; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum 10 c.c. every 2 hours. Total amount injected, 120 c.c. T° rose to 108.6° before death on third day. Death.

CASE 36.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 43. Supravaginal hysterectomy, double oophorectomy. Incision, 4-5 inches. No tetanus bacilli found. Period of incubation, 6 days; trismus, dysphagia, rigidity of cervical muscles, later opisthotonos; general convulsions; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used.

Subcutaneous injection of antitoxic serum, 3 injections, q. 8 hours, 20 c.c. Total amount injected, 60 c.c. Death.

CASE 37.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 14. Gunshot wound of foot. No tetanus bacilli found. Period of incubation, 7 days; characteristic; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 3 injections, 20 c.c. q. 8 hours. Total amount injected, 60 c.c. Death.

CASE 38.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 13. Punctured wound of sole of foot by nail. No tetanus bacilli found. Period of incubation, 4 days; pain in chest, then trismus, pain in neck with rigidity; general convulsions; treatment began on third day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, injections q. 6 hours. How long not stated. Recovery.

CASE 39.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 12. Lacerated wound, hand. No tetanus bacilli found. Characteristic. New York City Board of Health's antitoxin used. Subcutaneous injections of antitoxic serum administered daily, given in injections of 20 c.c. q. 12 hours. Length of period of treatment omitted. Death.

CASE 40.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 10. Blank cartridge wound of right hand. No tetanus bacilli found. Period of incubation, 8 days; slow development; cramp-like pain between scapulæ; then stiffness legs, right arm; trismus. On entering hospital right arm in convulsions. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 6 hours. How long not mentioned. Recovery.

CASE 41.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 28. Punctured wound left foot; nail. No tetanus bacilli found. Period of incubation, 7 days; virulent; stiffness of muscles of neck and face, trismus, involuntary defecation. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, details not furnished. T.° rose to 108.6° before death on third day.

CASE 42.—CHAS. H. GOODRICH, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 23. Right hand lacerated by buzz saw. No tetanus bacilli found. Period of incubation, 14 days; pain in hand, stiffness jaws, neck and abdomen; head retracted; general convulsions; treatment began on third day; continued 3 days. Glibler's antitoxin used. Subcutaneous injection of antitoxic serum third, fourth, and fifth days; 9 doses, 1 q. 8 hours, $8\frac{1}{2}$ c.c. Total amount injected, 75 c.c. Serum treatment discontinued as patient grew worse. Death on seventh day.

CASE 43.—CHAS. H. GOODRICH, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 29. Punctured wound of foot from nail. Period of incubation, 6 days; rigidity of jaw; advanced rapidly; pain in back; dysphagia; opisthotonos; general convulsions; treatment began on fourth day; continued 2 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, fourth day, 2 injections, 20 c.c. and 12 c.c. Fifth day, 2 injections 20 c.c. each. Total amount injected, 72 c.c. Death on sixth day in sudden and severe convulsions.

CASE 44.—CHAS. H. GOODRICH, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 56. Colectomy for cancer splenic flexure. Anastomosis with bobbin of raw potato. No tetanus bacilli found. Period of incubation, 10 days; eighth day, great abdominal pain; tenth day, choking sensation and dysphagia; trismus and neck rigidity followed; general convulsions; treatment began on first day; continued 2 days. Brooklyn Health Department's antitoxin used. Subcutaneous injection of antitoxic serum, first day, in evening, 20 c.c.; second day, A.M., 20 c.c.; P.M., 30 c.c. Total amount injected, 70 c.c. Death during tenth severe general convulsion on second day.

CASE 45.—HALL AND CLOPTON, St. Louis; private. Age 55. Penetrating wound of sole of right foot. No tetanus bacilli found. Period of incubation, 13 days; spasms in right leg extending up into thigh; next, trismus with dysphagia; symptoms of mild type; treatment began on first day; continued 10 days.

Subcutaneous injection of antitoxic serum, 1 injection of 10 c.c. daily for 10 days. Total amount injected, 1000 c.c. Wound excised first day. Disease lasted 12 days. Mild. Recovery.

CASE 46.—J. C. MORFIT, St. Louis; private. Age 30. Penetrating wound of toe; rusty nail. No tetanus bacilli found. Period of incubation, 7 days; severe; extreme trismus; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection, "large amount." Very severe case. Death on first day.

CASE 47.—J. C. MORFIT, Mullanphy Hospital, St. Louis. Age 19. Gunshot wound left hand. Had intercurrent tonsillitis. Tetanus bacilli found. Period of incubation, 11 days; risus sardonius, dysphagia, stiffness of neck, abdomen and extremities; opisthotonos; general convulsions; treatment began on first day; continued 10 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 6 injections; second day, 3; third day, 2; fourth day, 2; fifth to tenth days, 1 daily, all of 10 c.c. Total amount injected, 190 c.c. Recovery. "I have seen a more severe case recover without any treatment."

CASE 48.—WM. J. TAYLOR, St. Agnes Hospital, Philadelphia. Age 8. Punctured wound (healed) in palm of hand; nail. No tetanus bacilli found. Period of incubation, 6 days; entered hospital second day; stiffness of neck and back, trismus, marked convulsions, opisthotonos, risus sardonius; general convulsions; treatment began on first day; continued 1 day. Subcutaneous injection of antitoxic serum, first day, 30 c.c. about noon. Total amount injected 30 c.c. Discharged cured on third day.

CASE 49.—JAS. TYSON, Pennsylvania Hospital, Philadelphia. Age 53. Healed punctured wound plantar surface right foot. No tetanus bacilli found. Period of incubation, 9 days; trismus, rigidity of cervical muscles and those of jaw, back and abdomen; admitted fifth day; treatment began on fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. given about wound, and 30 c.c. and later 60 c.c. into abdomen. Total amount injected, 120 c.c. Death 24 hours after admission.

CASE 50.—ALFRED STENGEL Pennsylvania Hospital, Philadelphia. Age 27. Burn of arm (coal oil). No tetanus bacilli found. Period of incubation, 25 days; admitted 30 days after injury; profound trismus; slightest noise would produce general convulsions with opisthotonos; general convulsions; treatment began fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 3 injections 40 c.c. each; 9 A.M., 12 M. and 4 P.M. Total amount injected, 120 c.c. After 3 doses, carbolic acid injections given. Gradual recovery. Well in 25 days.

CASE 51.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore. Age 52. Punctured wound sole of foot, rusty nail. Period of incubation, 7 days; admitted second day; stiffness neck and jaws; almost absolute trismus; risus sardonius; rigid abdominal muscles; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 30 c.c. injected into axilla and 20 c.c., summary. Total amount injected, 50 c.c. Death on day of admission.

CASE 52.—C. A. PORTER, Massachusetts General Hospital. Age 55. Compound fracture right ankle. Leg amputated day before first symptoms. Period of incubation, 6 days; rigid neck; T. 105°; dysphagia; no general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours. Death on third day.

CASE 53.—C. A. PORTER, Massachusetts General Hospital. Age 29. Multiple lacerated dynamite wounds from knee to jaw right side of body. No tetanus bacilli found. Period of incubation, 7 days; dysphagia, rapid increase in severity; T. 100.2°, P. 68, R. 22; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum 20 c.c. q. 4 hours. Total amount injected, 80 c.c. Death in 17 hours.

CASE 54.—C. A. PORTER, Massachusetts General Hospital. Age 16. Blank cartridge wound of finger. Period of incubation, 6 days; opisthotonos, diaphragmatic breathing, trismus, dysphagia; T. 100.4°, P. 124, R. 22; treatment

began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. in pectoral region repeated in 6 hours and again in 4 hours. Total amount injected, 90 c.c. Death in 18 hours.

CASE 55.—C. A. PORTER, Massachusetts General Hospital. Age 11. Blank cartridge wound of palm. Tetanus bacilli found. Period of incubation, 9 days; slight risus, slight retraction of head; T. 100.5°, P. 84; treatment began on second day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours increasing to 20 c.c. q. 2 hours on last day. Death on sixth day.

CASE 56.—C. A. PORTER, Massachusetts General Hospital. Age 36. Blank cartridge wound left hand. No tetanus bacilli found. Period of incubation, 7 days; masseters, neck and abdominal muscles stiff; T. 99.8°, P. 70, R. 28; treatment began on second day; continued 2 days. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours. Doubled amount on second day. Death on third day.

CASE 57.—C. A. PORTER, Massachusetts General Hospital. Age 10. Blank cartridge wound left side thorax. No tetanus bacilli found. Period of incubation, 7 days; convulsions; no lung symptoms or dyspnea; T. 102°, P. 150, R. 35; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 5 c.c., 15c.c., 20 c.c. q. 3 hours. Death on second day.

CASE 58.—C. A. PORTER, Massachusetts General Hospital. Age 11. Blank cartridge wound, left palm. Tetanus bacilli found. Period of incubation, 7 days; trismus and dysphagia; T. 99.8°, P. 92, R. 18; treatment began on second day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c. on entrance, 10 c.c. q. 3 hours. Death on fourth day. T. 108°.

CASE 59.—C. A. PORTER, Massachusetts General Hospital. Age 13. Compound fracture of forearm. No tetanus bacilli found. Period of incubation, 7 days; very severe; T. 104.8°, P. 140, R. 27; general convulsions every 20 seconds; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. after amputation of arm, 20 c.c. 6 hours later. Total amount injected, 50 c.c. Death in 23 hours.

CASE 60.—C. A. PORTER, Massachusetts General Hospital. Age 27. Punctured wound foot; nail. No tetanus bacilli found. Period of incubation, 14 days; mild at first, gradually increasing; T. 104°, P. 72, R. 23; no general convulsions; treatment began on second day. Subcutaneous injection of antitoxic serum, 20 c.c. q. 6 hours. Gradual recovery in 23 days.

CASE 61.—C. A. PORTER, Massachusetts General Hospital. Age 9. Blank cartridge wound, hand. No tetanus bacilli found. Period of incubation, 10 days; trismus, spasms of flexors of hand, opisthotonos on stimulation; T. 100.6°, P. 112, R. 25; general convulsions; treatment began on second day; continued 4 days. Subcutaneous injection of antitoxic serum, every 4 hours for 4 days in varying amounts. Discharged after 33 days.

CASE 62.—C. A. PORTER, Massachusetts General Hospital. Age 28. Blank cartridge wound, left hand. Period of incubation, 7th day; trismus and rigidity muscles neck and abdomen; T. 100°, P. 80, R. 22; no general convulsions. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Recovery in 26 days. Never had convulsions.

CASE 63.—JAMES BELL, Royal Victoria Hospital, Montreal. Age 29. Punctured wound of sole of foot; rusty nail. Period of incubation, 6 days; stiffness of jaw and back muscles; jolting caused spasms; later, spasms of muscles of abdomen and extremities; risus sardonicus; general convulsions; treatment began on fifth day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 10 c.c. subcutaneously; second day, 10 c.c. subcutaneously. Total amount injected, 20 c.c. Death on seventh day.

CASE 64.—JAMES BELL, Royal Victoria Hospital, Montreal. Age 18. Punctured wound of foot; nail. Period of incubation, 8 days; stiffness of jaw,

dysphagia, constricted feeling in chest; treatment began on fifth day; continued 6 days. Giber's and Roux's antitoxin used. Subcutaneous injection of antitoxic serum, sixth day: 11:30 A.M., 1 c.c.; 5:30 P.M., 1 c.c. Seventh day: 11 A.M., 1 c.c.; 6 P.M., 10 c.c. Eighth day: 6 A.M., 10 c.c.; 12 M., 25 c.c.; 6 P.M., 25 c.c. Ninth day: 12 P.M., 25 c.c.; 6 A.M., 25 c.c.; 12 M., 10 c.c. Tenth day: 12 P.M., 10 c.c.; 12 M., 25 c.c.; 6 P.M., 25 c.c. Eleventh day: 12 P.M., 85 c.c. Total amount injected, 278 c.c. Death on eleventh day.

CASE 65.—JAMES BELL, Royal Victoria Hospital, Montreal. Age 42. Compound fracture tibia and fibula left leg. Tetanus bacilli found. Period of incubation, 10 days; stiffness of jaws, dysphagia, risus sardonicus, rigidity of abdominal muscles, rectal tenesmus, spasms of muscles of face; treatment began on second day; continued 19 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day: 3 P.M., 30 c.c.; 11 P.M., 20 c.c. Third to eighth days, 20 c.c. daily; ninth day, 10 c.c.; fifteenth day, 20 c.c.; eighteenth day, 20 c.c.; twenty-first day, 20 c.c. Total amount injected, 240 c.c. Recovery in 44 days.

CASE 66.—JAMES BELL, Royal Victoria Hospital, Montreal. Slight superficial cut on palm of left hand. No tetanus bacilli found. Period of incubation, 12 days; dysphagia, face swollen, backache, constricted feeling in chest, opisthotonos; injured hand flexed at wrist, thumb adducted; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 10 c.c. into wound and 20 c.c. into right loin on admission; 12 M., 40 c.c. into left loin. Total amount injected, 70 c.c. Recovery.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM INJECTED INTO VARIOUS STRUCTURES.

CASE 1.—ROSWELL PARK, Buffalo General Hospital. Age 10. A punctured wound of sole of foot, by tack. Period of incubation, 8 days; marked tetanus and opisthotonos; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 30 c.c., at 7 P.M.; 23 c.c., 11 P.M. Intraneural injection, 3 c.c., into sciotic; 3 c.c., into anterior crural. Intraspinal injection at two places, each 12 c.c. Total amount injected, 83 c.c. Death one-half hour after second injection.

CASE 2.—GEO. T. VAUGHAN, Emergency Hospital, Washington, D. C. Age 25. Thumb and two fingers destroyed by burn. Dressed with ichthyol and iodoform. Period of incubation, 16 days; trismus, abdominal rigidity, opisthotonos; general convulsions; treatment began first day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours for first 2 days. Intravenous injection, 1st day 10 c.c. Intracranial, 3rd and 4th days 30 c.c. daily under dura. Total amount injected, 310 c.c. Death on 4th day.

CASE 3.—H. B. GESSNER, Charity Hospital, New Orleans, La. Age 18. Railroad injury to right foot and laceration of the scalp. Period of incubation, 11 days; severe; temperature, 102°; general convulsions; treatment began on second day; continued one day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. into foot. Intraspinal, 162 m. Total amount injected, 21 c.c. Convulsions disappeared in 10 days, cured in 34 days.

CASE 4.—S. LOGAN, Charity Hospital, New Orleans, La.; service Dr. Matas. Age 13. Toy pistol wound on right hand. Period of incubation, 8 days; mild, slight opisthotonos, few convulsions; general convulsions; treatment began on first day; continued 3 days. P. D. & Co.'s antitoxin used. Intraneural injection, perineural 50 c.c. Intraspinal injection, 10 c.c. Total amount injected, 60 c.c. Course and termination not stated.

CASE 5.—C. B. G. DE NANCREDE; private patient. Age 18. Severe injury of foot. Early manifestations of tetanus not stated. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Intraneural injection,

tion, at time of amputation into severed nerve trunks; intraspinal injection, at time of amputation. Amputation through middle of leg. Recovery.

CASE 6.—PATCH, Montreal General Hospital. Age 5. Traumatic amputation of thigh; bone and muscles protruding. No tetanus bacilli found. Period of incubation, 9 days; admitted second day unconscious, trismus, opisthotonos; T. 99.2°–104.4°; general convulsions, 2; treatment began second day; continued 1 hour. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. Intraspinal injection, 20 c.c. Intracranial, 10 c.c. Total amount injected, 40 c.c. Death 1 hour after injections.

CASE 7.—PATCH, Montreal General Hospital. Age 16. Laceration of forehead. Period of incubation, 8 days; trismus and dysphagia gradually increasing for 6 days; on admission spastic gait, head retracted to left, trismus, paralysis of tongue, respiratory distress, rt. facial paralysis; treatment began on sixth day; continued 2 days. Roux's antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. on sixth day. Intraspinal injection, sixth day, 10 c.c.; seventh day, 15 c.c. Total amount injected, 30 c.c. Improvement began 4 days after admission. Up 10 days later. Recovery.

CASE 8.—PATCH, Montreal General Hospital. Age 5. Small wound on sole of foot, healed, enclosing drop pus. No tetanus bacilli found. Period of incubation, 10 to 14 days; stiffness neck and arms in morning; 10 P.M., general convulsions, opisthotonos; next day trismus, twitching face, all muscles in tonic convulsions, T. 98°; general convulsions; treatment began second day; continued 15 hours. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. first; intraspinal injection later, 10 c.c. Total amount injected, 20 c.c. Death 15 hours after first injection. T. 109°.

CASE 9.—WM. M. MASTIN, Mobile City Hospital, Mobile, Ala. Age 35. Following abortion. No tetanus bacilli found. Period of incubation, 7 to 8 days; mild trismus, muscular rigidity, opisthotonos; general convulsions; treatment began on second day; continued 5 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, third to sixth days, 20 c.c. q. 4 to 8 hours. Intraspinal injection, second day, 20 c.c. Total amount injected, 400 c.c. Morphine and chloral also given. Recovery.

CASE 10.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland. Age 26. Blank cartridge wound, hand; healing. No tetanus bacilli found. Period of incubation, 7 days; trismus; during next 48 hours muscles of neck, back and legs rigid; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. Intracranial, 2½ c.c. into each lateral ventricle. Total amount injected, 10 c.c. T. rose from 100° to 109° (axillary). Death on fourth day.

CASE 11.—DUDLEY TAIT, French Hospital, San Francisco. Age 27. Slight abrasion received in cleaning hides. No tetanus bacilli found. Period of incubation, 6 days; acute, characteristic symptoms; entered hospital second day; treatment began second day; continued 3 days. P. D. & Co.'s antitoxin used. Intravenous injection, several of 8 c.c. on third day. Intracranial injection, second day, 1 and 1½ c.c. in each frontal lobe. Death on fourth day.

CASE 12.—DUDLEY TAIT, San Francisco; private patient. Age 26. Lacerated wound left index finger. Period of incubation, 14 days; subacute; general convulsions; treatment began on first day; continued 5 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day 4 injections, 20 c.c., afterwards 2 injections daily. Intravenous injection, first day, 4 injections 1½ c.c., afterwards 2 daily. Total amount injected, 36 c.c. Death.

CASE 13.—DUDLEY TAIT, San Francisco; private patient. Age 30. Wound, right hand (stable man). No tetanus bacilli found. Period of incubation, 10 days; mild; general convulsions; treatment began first day; continued few days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 2 injections first day, repeated daily. Intravenous injection, 2 injections first day, repeated daily. Recovery.

CASE 14.—GEO. E. BREWER, Roosevelt Hospital, New York City. Age 14. Blank cartridge wound base of left forefinger. No tetanus bacilli found. Period

of incubation, 6 days; severe trismus; head retracted; general convulsions with opisthotonos and spasms of extremities; general convulsions; treatment began first day; continued 2 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 20 c.c. Intravenous injection, second day, 20 c.c. Total amount injected, 40 c.c. Death second day.

CASE 15.—GEO. E. BREWER, Roosevelt Hospital, New York City. Age 21. Infected blank cartridge wound base left forefinger. No tetanus bacilli found. Period of incubation, 8 days; some trismus, stiffness back of neck, painful dysphagia, opisthotonos; general convulsions; treatment began second day; continued 10 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day, 4 doses; third day, 6 doses; fourth day, 2 doses; fifth day, 2 doses; sixth day, 3 doses; seventh day, 4 doses; eighth day, 3 doses; ninth day, 4 doses; tenth day, 3 doses; each 20 c.c. Intravenous injection, fifth day, 4 doses 20 c.c. Total amount injected, 640 c.c. Dyspnoea and cyanosis third day with dysphagia and strangling. No symptoms until seventh day. Then rigidity of muscles. Later became comfortable. Death twelfth day.

CASE 16.—GEO. E. BREWER, Roosevelt Hospital, New York City. Age 24. Compound fracture ulna with lacerated elbow. No tetanus bacilli found. Period of incubation, 7 days; trismus, pain back of neck, opisthotonos, involuntary micturition; treatment began first day; continued 2 days. Subcutaneous injection of antitoxin serum, first day, 60 c.c. Intravenous injection, first day, 40 c.c. with 1,000 c.c. saline solution; same second day. Total amount injected, 140 c.c. Death on second day.

CASE 17.—HENRY HEIMAN, Mt. Sinai Hospital, New York. Age 12. Penetrating wound right foot; nail. Tetanus bacilli found. Period of incubation, 11 days; severe rigidity, neck, back and legs; trismus, hyperacusis; treatment began third day; continued 8 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections, 20 c.c. Intraspinal injection, 3 injections of 20 c.c. Total amount injected, 220 c.c. Recovery. Question if due to serum.

CASE 18.—A. V. MOSCHCOWITZ, Mt. Sinai Hospital, New York. Age 18. Blank cartridge, palm hand. No tetanus bacilli found. Period of incubation, 7 days; mild at first, increasing in severity; treatment began second day; continued 2 days. Antitoxin of Institute Pasteur, Paris, used. Intravenous injection, second day, 2 injections of 20 c.c. and 10 c.c. Intracranial injection, third day, 5 c.c. Total amount injected, 35 c.c. Death.

CASE 19.—WILLY MEYER, German Hospital, New York. Age 27. Appendectomy through rectus muscle. No tetanus bacilli found. Period of incubation, 10 days; trismus, pain in muscles of jaw; rigidity and pain in muscles of neck, risus sardonius, opisthotonos, dysphagia; treatment began second day; continued 6 days. Subcutaneous injection of antitoxic serum, third day, 10 c.c.; seventh and eighth days, 10 c.c.; ninth day, 15 c.c. Intraspinal injection, second day, 2½ c.c.; third day, 10 c.c.; fifth day, 12 c.c. and 15 c.c. Total amount injected, 84½ c.c. Gradual recovery.

CASE 20.—FRED KAMMERER, German Hospital, New York. Age 38. Appendectomy during quiescent period. Primary incision. Tetanus bacilli found. Period of incubation, 9 days; very severe, risus sardonius, rigidity muscles neck, abdomen; later paralysis muscles deglutition, rigidity of intercostals; general convulsions; treatment began first day; continued 11 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 30 c.c.; sixth, seventh, eighth, ninth, tenth, eleventh days, 2 injections of 30 c.c. Intraspinal injection, second day, 15 c.c. Intravenous injection, third, fourth and fifth days, each, 30 c.c. Total amount injected, 495 c.c. Improvement for 9 days, then increase in symptoms. Death twelfth day.

CASE 21.—H. B. WILLIAMS, Hudson St. House of Relief, N. Y. City. Age 12. Blank cartridge wound left thigh; suppurating; 4th July, 1899. Period of incubation, 4 days; stiffness of thigh, 5 days later trismus, risus sardonius, opisthotonos; general convulsions; treatment began seventh day; continued 1

day. Subcutaneous injection of antitoxic serum, seventh day, 20 c.c. Intracranial injection, seventh day, 5 c.c. into each frontal lobe. Total amount injected, 30 c.c. Death on eighth day.

CASE 22.—H. B. WILLIAMS, Hudson St. House of Relief, N. Y. City. Age 13. Blank cartridge wound base of left thumb. Dressed 5 hours after injury; no subsequent dressing. Period of incubation, 5 days; sudden stiffness jaw, next day mild opisthotonos and marked trismus; general convulsions; treatment began second day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c. Intracranial injection, 10 c.c. into each lateral ventricle. Total amount injected, 70 c.c. Death on third day.

CASE 23.—H. B. WILLIAMS, New York Hospital. Age 54. Compound fracture of leg. Amputated at hospital 6 days later. No tetanus bacilli found. Period of incubation, 9 days; trismus; treatment began first day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Intravenous injection, 20 c.c. in 450 c.c. salt solution. Intracranial injection into each lateral ventricle. Total amount injected, 20 c.c. + . Death on second day. Leg amputated 6 days after injury.

CASE 24.—H. B. WILLIAMS, New York Hospital. Age 17. Blank cartridge wound palm right hand. No tetanus bacilli found. Period of incubation, 6 days; trismus and mild risus sardonicus; treatment began second day; continued 11 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day, into chest and abdomen, 20 c.c.; fourth day, q. 6 hours, 20 c.c., 10 c.c., 20 c.c.; fifth day, 20 c.c. Intraspinal injection, sixth to twelfth days inclusive, daily 20 c.c. Intravenous injection, third day, 50 c.c. Total amount injected, 290 c.c. Death on twelfth day.

CASE 25.—R. R. CANNA, King's County Hospital, Brooklyn. Age 40. Rusty nail from stable into foot. No trouble locally with wound. Tetanus bacilli found. Period of incubation, 4 days; entered hospital seventh day, trismus had been present 3 days, opisthotonos; general convulsions; treatment began fourth day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. Intraspinal injection, 40 c.c. Total amount injected, 60 c.c. Foot amputated; death in coma day after admission.

CASE 26.—R. R. CANNA, King's County Hospital, Brooklyn. Age 22. R. R. traumatic amputation right thigh. Tetanus bacilli found. Period of incubation, 8 days; difficulty in opening mouth; trismus followed delirium; opisthotonos; treatment began first day; continued 15 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c. first day. Intraspinal injection, 15 c.c., first day; 20 c.c. each day subsequently until death. Total amount injected, 335 c.c. Death on fifteenth day.

CASE 27.—GEO. PICKERELL, U. S. N., U. S. Naval Hospital, San Juan, Porto Rico. Age 22. Punctured wound inner side right leg, just below knee. Period of incubation, 10 days; ninth day coryza with soreness and stiffness of jaws; tenth day symptoms marked; eleventh day pronounced trismus, on auscultation murmur over muscles jaw, neck and chest; general convulsions, eleventh day, 1 of fifteen minutes, thirteenth day, 3; treatment began second day; continued 6 days. "French" antitoxin used. Subcutaneous injection of antitoxic serum, second day, 10 c.c.; third day, 20 c.c.; fourth, fifth, sixth, each 20 c.c. Intracranial injection, third day right lateral ventricle and subdural, each 3 c.c. Total amount injected, 100 c.c. After fourth day gradual improvement. Recovery 55 days after injury.

CASE 28.—J. B. CARNETT, Philadelphia Hospital. Age 9. Nail perforated shoe; punctured wound of sole. No tetanus bacilli found. Period of incubation, 6 days; admitted second day; trismus 24 hours' duration; general convulsions 12 hours before; general spastic condition of muscles; general convulsions; treatment began second day; continued few hours. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. Intraneural injection, 30 c.c. into great sciatic at gluteal fold. Intraspinal injection, 35 c.c. Total amount injected, 95 c.c. Given at one time under anæsthetic. Death 3 hours later.

CASE 29.—JAS. TYSON, Pennsylvania Hospital, Philadelphia. Age 27. No wound except that of tongue bitten during first convulsion 4 days before. Retained placenta found at autopsy. No tetanus bacilli found. On admission, trismus, general muscular rigidity, increased reflexes; general convulsions; treatment began fourth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c., later, 20 c.c. Intraspinal injection, 20 c.c., later, 30 c.c. Total amount injected, 80 c.c. Death 24 hours after admission into hospital.

CASE 30.—JAS. TYSON, Pennsylvania Hospital, Philadelphia. Age 26. Small punctured wound right foot; rusty nail. No tetanus bacilli found. Period of incubation, 6 days; only painful mastication; reflexes increased; seventh day, general muscular rigidity; ninth day, convulsions; general convulsions; treatment began first day; continued 2 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, first day, 30 c.c. over sciatic nerve; later, again, 30 c.c.; second day, q. 4 hours 60 c.c. Intraspinal injection, first day, 30 c.c. Total amount injected, 420 c.c. Death on third day.

CASE 31.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 43. Punctured wound left great toe; rusty nail. Tetanus bacilli found. Period of incubation, 8 days; stiffness muscles jaw and neck; progressed rapidly to opisthotonos; general convulsions; treatment began second day; continued 5 days. Subcutaneous injection of antitoxic serum deep into thigh muscles twice daily for several days, 10 c.c. Intracranial injection, once, 5 c.c. into each frontal lobe. Total amount injected, 90 c.c. Death on seventh day.

CASE 32.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 50. Gangrene right foot from frost bite; amputation. No tetanus bacilli found. Five days after admission retraction head; 2 hours later opisthotonos, risus sardonicus; 3 hours later general convulsions; injection of antitoxic serum, 5 c.c. into thigh muscles first day and 15 c.c. second day, 5 c.c. under skin. Intravenous injection, 10 c.c. second day. Total amount injected, 35 c.c. Death on second day.

CASE 33.—NATHAN JACOBSON, St. Joseph's Hospital, Syracuse, N. Y. Blank cartridge wound right hand July 4th, 1899. Wound opened on admission to hospital and was removed. No tetanus bacilli found. Period of incubation, 7 days; admitted on fourth day with trismus, stiffness neck muscles and general convulsions; general convulsions; treatment began fourth day; continued 2 days. Subcutaneous injection of antitoxic serum, fourth day, 2 injections, 10 c.c. Intracranial injection, fifth day, twice, 10 c.c. Total amount injected, 40 c.c. Death, 7 A.M. on sixth day.

CASE 34.—H. B. WILLIAMS, Hudson St. House of Relief, N. Y. City. Age 22. Punctured wound left foot; rusty nail. No tetanus bacilli found. Period of incubation, 5 days; stiffness of neck and jaw muscles; treatment began fifth day; continued 1 day. N. Y. City Health Department's antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection, 10 c.c. Intraspinal injection, 1 injection 10 c.c. Total amount injected, 20 c.c. Death on sixth day of disease; one day after admission.

CASE 35.—C. A. PORTER, Massachusetts General Hospital. Age 13. Blank cartridge wound, left palm. Tetanus bacilli found. Period of incubation, 4 days; pain in back of neck, trismus; risus sardonicus; convulsions; general convulsions; treatment began on fourth day; continued 1 day. P. D. & Co.'s antitoxin used. Intraneural injection, median and ulnar at wrist, 1 c.c.-3 c.c. Intraspinal injection, 11 c.c. twice. Total amount injected, 26 c.c. Death 16 hours after admission.

CASE 36.—C. A. PORTER, Massachusetts General Hospital. Age 10. Cannon cracker wound, right arm. Tetanus bacilli found. Period of incubation, 4 days; trismus, convulsions, dysphagia; T. 100.2°, P. 110, R. 30; general convulsions; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection about wound. Intraneural injection into roots of brachial plexus. Death 16 hours after admission.

CASE 37.—C. A. PORTER, Massachusetts General Hospital. Age 15. Blank cartridge wound, right palm. Tetanus bacilli found. Period of incubation, 7 days; admitted second day; trismus, risus sardonicus, convulsions, pain in neck and abdomen, diaphragmatic breathing; general convulsions; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum every 4 hours. Intraneural injection, median and ulnar at wrist, $4\frac{1}{2}$ c.c. each. Intraspinal injection every 6 hours. Death 17 hours after admission.

CASE 38.—C. A. PORTER, Massachusetts General Hospital. Age 17. Knife cut second and third fingers. Period of incubation, 3 weeks; stiffness in jaws and neck, pain in back; T. 102.2° , P. 90; general convulsions; treatment began on second day; continued 1 day. Intraneural injection into brachial plexus, 5 c.c. Intraspinal injection, 10 c.c. Total amount injected, 15 c.c. Death on third day.

CASE 39.—C. A. PORTER, Massachusetts General Hospital. Age 17. Wound right leg, cannon cracker. Tetanus bacilli found. Period of incubation, 7 days; general slight rigidity, marked trismus; T. 101° , P. 96, R. 28; treatment began third day; continued 2 days. P. D. & Co.'s and Massachusetts State B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. Intravenous injection, 30 c.c. in salt solution; 50 c.c. q. 6 hours, second day. Total amount injected, 200 c.c. Death 48 hours after admission.

CASE 40.—C. A. PORTER, Massachusetts General Hospital. Age 17. Blank cartridge wound of hand. Tetanus bacilli found. Period of incubation, 7 days; severe general convulsions; T. 102.8° , P. 152, R. 28; general convulsions; treatment began on first day; continued 2 hours. Subcutaneous injection of antitoxic serum, 10 c.c. Intracranial injection, 3 c.c., into each lateral ventricle. Total amount injected, 16 c.c. Death in $2\frac{1}{2}$ hours.

CASE 41.—C. A. PORTER, Massachusetts General Hospital. Age 33. Punctured wound of foot; nail. No tetanus bacilli found. Period of incubation, 5 days; trismus, moderate degree; T. 99.2° , P. 88, R. 22; general convulsions; treatment continued 3 days. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Intracranial injection, 3 c.c., into each lateral ventricle, second day. Total amount injected, 186 c.c. Death 72 hours after admission.

CASE 42.—C. A. PORTER, Massachusetts General Hospital. Age 73. Frozen toe. No tetanus bacilli found. Period of incubation, 2 weeks; trismus, risus sardonicus; general convulsions; treatment began first day; continued 8 hours. Pasteur Institute antitoxin used. Intravenous injection, 40 c.c., twice. Intracranial injection, 3 c.c. into each frontal lobe and 2 c.c. under dura. Total amount injected, 90 c.c. Death 8 hours after admission.

CASE 43.—C. A. PORTER, Massachusetts General Hospital. Age 56. Nail wound, right heel. Period of incubation, 2 weeks; risus and tense abdomen; no general convulsions; treatment began fourth day. Subcutaneous injection of antitoxic serum, 20 c.c. Intraneural injection, 1 c.c. into anterior crural and sciatic. Death on fifteenth day. Not due to tetanus but to bed sores, etc.

CASE 44.—C. A. PORTER, Massachusetts General Hospital. Age 18. Machine crushed second and third fingers. Tetanus bacilli found. Period of incubation, 13 days; trismus; pain in abdomen; T. 101.6° , P. 90, R. 24; general convulsions; treatment began second day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 12 hours. Intraneural injection, musculospiral, median, and ulnar nerves injected, 10 c.c. each. Intraspinal injection, 10 c.c. twice. Total amount injected, 60 c.c. +. Recovery. Discharged thirtieth day.

CASE 45.—W. J. ROE, Jefferson Medical College Hospital. Age 14. Appendectomy during quiescent period. No tetanus bacilli found. Period of incubation, 9 days; dull pain in head and neck, trismus, retraction of head, risus sardonicus, opisthotonos, dysphagia, tonic rigidity muscles of abdomen and extremities; general convulsions; treatment began first day; continued 6 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 1230 c.c. Intraspinal injection, 175 c.c. antitoxin and 13 c.c. of a 25 per cent.

MgSO₄ solution. Intravenous injection, 90 c.c. Total amount injected, 1495 c.c. Death.

CASE 46.—JAMES BELL, Royal Victoria Hospital, Montreal. Lacerated wrist; glass. Tetanus bacilli found. Period of incubation, 11 days; stiffness and numbness in fingers of injured arm; next day, trismus; fingers flexed into palm; treatment began first day; continued 18 days. Subcutaneous injection of antitoxic serum, first, second and third days, 20 c.c.; fourth to seventh days, 60 c.c. daily. Intraspinous injection, seventeenth day, 10 c.c.; eighteenth day, 10 c.c. Total amount injected, 320 c.c. Recovery in 31 days.

CASE 47.—JAMES BELL, Royal Victoria Hospital, Montreal. Age 9. Contusion and laceration of skin over tibia. Tetanus bacilli found. Period of incubation, 47 days; sore tongue, weak, backache, spastic condition lower extremities and retraction of head; general convulsions; treatment began *first day after injury*, 4 days after first symptoms; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. *first day after injury as a prophylactic*; fourth day of disease, 10 c.c. Intraneural injection, 7 c.c. into anterior crural. Intraspinous injection, 7 c.c. Total amount injected, 29 c.c. Death on fifth day.

CASE 48.—JAMES BELL, Royal Victoria Hospital, Montreal. Age 5. Infected vaccination wound. Tetanus bacilli found. Period of incubation, 23 days; stiffness arm and jaw, neck stiff, painful, sternomastoid contracted (operation), opisthotonos, numerous spasms; general convulsions; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c., 4 c.c., 10 c.c. Intraneural injection, 4 c.c. into sheath of musculo-spiral, musculo-cutaneous, and ulnar; enough to swell median 3 times its natural size was injected. Intraspinous injection, 4 c.c.; later, 4 c.c. by cervical puncture; still later, 10 c.c. as above. Intravenous injection, 4 c.c. Total amount injected, 58 c.c. +. Death on second day.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS ADMINISTERED BY INTRASPINAL INJECTION WITH ANTITOXIC SERUM.

CASE 1.—R. MATAS, New Orleans; private patient. Age 24. Vaccination. Period of incubation, 17 days; severe tonic spasm of all voluntary and respiratory muscles; treatment began first day. P. D. & Co.'s antitoxin used. Intraspinous injection of antitoxic serum administered daily, 50 c.c. Total amount injected, 50 c.c. Result not stated.

CASE 2.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 10. Lacerated wound left heel; cut with glass 4 weeks before admission, nearly healed. Period of incubation, 26 days; trismus, neck arched, opisthotonos; hypersensitive; general convulsions; treatment began third day; continued 12 days. P. D. & Co.'s antitoxin used. Intraspinous injection of antitoxic serum administered daily, 10 c.c. q. 6 hours for 5 days; 10 c.c. q. 8 hours for 1 day; 10 c.c. once daily for 6 days. Total amount injected, 290 c.c. Left hospital in 4 weeks, well.

CASE 3.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 9. Boy running barefoot, number scratches and cuts on feet. Tonic convulsions, head thrown back, opisthotonos, extremities rigid; general convulsions; treatment began first day; continued 5 days. P. D. & Co.'s antitoxin used. Intraspinous injection of antitoxic serum administered daily, 10 c.c. q. 8 hours. Total amount injected, 150 c.c. Death on fifth day.

CASE 4.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 14. Small punctured wound right foot; nail. No tetanus bacilli found. Period of incubation, 8 days; trismus, opisthotonos, extremities rigid; treatment began first day; continued 36 hours. P. D. & Co.'s antitoxin used. Intraspinous injection of antitoxic serum administered daily, 10 c.c. q. 6 hours. Total amount injected, 50 c.c. Death in 36 hours.

CASE 5.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 34. Three unclean wounds left hand; present 3 to 4 weeks. No tetanus bacilli found. Period of incubation, 21 days; 5 days before admission, pain in back and dizziness; 3 days before, pain and stiffness of back, trismus; day before, convulsions, opisthotonos, risus sardonius; general convulsions; treatment began third day; continued 11 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 6 hours for 6 days, 240 c.c.; 10 c.c. once daily for 5 days, 50 c.c. Total amount injected, 290 c.c. Recovering.

CASE 6.—WALLACE I. TERRY, San Francisco City and County Hospital. Age 32. Punctured wound outer side plantar aspect right foot; nail. No tetanus bacilli found. Period of incubation, 7 days; stiffness neck and trismus, general convulsions, first day, opisthotonos; general convulsions; treatment began on first day; continued 4 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, first day, 90 c.c.; second day, 30 c.c.; third day, 20 c.c.; fourth day, 19½ c.c. Total amount injected, 159½ c.c. Death on fourth day.

CASE 7.—WILLY MEYER, German Hospital, N. Y. City. Age 37. Superficial wound over right parietal; fell from elevated railroad. Immediate suture, suppuration, reopened. Period of incubation, 5 days; trismus; 4 days later tetanus; general convulsions; treatment began on seventh day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, single injection, 10 c.c. Total amount injected, 10 c.c. Death next day.

CASE 8.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 12. Blank cartridge wound right hand, July 4th. No tetanus bacilli found. Period of incubation, 7 days; stiffness in jaw, pain back neck, and right side chest; hand with claw-like contraction digits, abdominal muscles rigid; treatment began on second day; continued 12 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, second day, 8 c.c.; third day, 11 c.c.; fourth day, 12 c.c.; fifth day, 10 c.c.; sixth day, 12 c.c.; seventh day, 12 c.c.; eighth day, 15 c.c.; thirteenth day, 15 c.c. Spinal fluid withdrawn on second day, 22 m.; third day, 12 m.; fourth day, 5 m.; fifth day, 40 m.; sixth day, 2 m.; seventh day, 35 m.; eighth day, 45 m. Total, 161 m. withdrawn. Total amount injected, 92 c.c. Fifteenth day sat up in bed. Seventeenth day out of bed. Eighteenth day opened mouth. Nineteenth day discharged cured. 161 m. Cerebrospinal fluid withdrawn.

CASE 9.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 10. Left wrist cut on broken bottle while vaulting garden fence. Period of incubation, 5 days; on fifth day abdominal pain with tonic contraction muscles; treatment began second day; continued 5 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, once daily for 5 days, 9 c.c.—14 c.c. at a dose, first withdrawing cerebrospinal fluid. Total amount of spinal fluid withdrawn, 605 m. Total amount injected, 59 c.c. Sat up thirteenth day. Discharged well seventeenth day.

CASE 10.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 17. Blank cartridge wound, palmar surface right hand, July 4th. Period of incubation, 8 days; severe pain in head, dyspnoea, inability to articulate, muscular twitchings, trismus, rigid intercostals, abdomen rigid, left hand claw-like, contraction fingers, opisthotonos marked; general convulsions, 10; treatment began on second day; continued 4 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, once daily, each time preceded by withdrawal of cerebrospinal fluid, amounting in all to 1556 m. Injections each 18 c.c.—20 c.c. Total amount injected, 78 c.c. Gradual improvement, stiffness of legs last to disappear. Recovery in 1 month.

CASE 11.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 24. Blank cartridge wound, left hand, July 4th. No tetanus bacilli found. Period of incubation, 10 days; trismus, abdominal muscles rigid; general convulsions 4 days later; treatment began on fourth day; continued 9 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum admin-

istered daily, on fourth, fifth, sixth and twelfth days, injection preceded by withdrawal of cerebrospinal fluid amounting to 3610 m. Injections of 20 c.c. each. Total amount injected, 80 c.c. Steady improvement, sat up in bed on fifteenth day. Discharged well on twentieth day.

CASE 12.—H. G. MUDD, St. Luke's Hospital, St. Louis. Age 26. Small opening in left side scrotum, operation for varicocele. Tetanus bacilli found. Period of incubation, 7 days; very virulent; constant opisthotonos, with clonic spasms every few minutes; general convulsions; treatment began on second day; continued 1 day. Mulford's antitoxin used. Intraspinal injection of antitoxic serum administered daily, 1 injection, lumbar puncture. Total amount injected, 20 c.c. Death 16 hours after injection. Operation performed by man connected with advertising institution.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRAMUSCULAR INJECTION.

CASE 1.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 17. Injury from moving train. Compound fracture occipital bone and compound comminuted fracture right hand. Tetanus bacilli found. Period of incubation, 11 days; difficulty in opening mouth, trismus and dysphagia, later slight localized spasm; treatment began on first day; continued 9 days. P. D. & Co.'s antitoxin used. Intramuscular injection of antitoxic serum, every 4 hours for 9 days 10 c.c. Total amount injected, 540 c.c. Amputation forearm second day. Recovery.

CASE 2.—J. SHELTON HORSLEY, Memorial Hospital, Richmond, Va. Age 25. Gunshot wound right thigh, fracturing femur. Period of incubation, 5 days; clonic spasm right thigh and leg; after 18 hours violent general convulsions; general convulsions; treatment began on first day; continued 4 days. Mulford's antitoxin used. Intramuscular injection of antitoxic serum, deep thigh injections attempting to enter nerves without exposing them, 10 c.c. every 8 hours. Total amount injected, 120 c.c. Death on fourth day.

CASE 3.—ANDREW SLOAN, St. Luke's, Utica. Age 12. Slight cartridge wound left hand. No tetanus bacilli found. Period of incubation, 11 days; trismus, tonic contractions muscles legs, back, abdomen, face, thorax, arms; second day; T. 102°-104°; treatment began on third day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Intramuscular injection of antitoxic serum administered daily, twice daily deep into thigh 60 c.c. Total amount injected, 720 c.c. Extensive urticaria. Additional medication, chloral, bromides, morphia. Gradual recovery.

CASE 4.—R. R. CANNA, King's County Hospital, Brooklyn. Age 49. Punctured wound of foot. Tetanus bacilli found. Trismus, clonic convulsions, opisthotonos. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum administered daily, every 4 hours in doses of 20-40 c.c. Death in coma.

CASE 5.—R. R. CANNA, King's County Hospital, Brooklyn. Age 37. Punctured wound, foot; rusty nail. Tetanus bacilli found. Period of incubation, 3 days; difficult swallowing, trismus, opisthotonos; general convulsions; treatment began on third day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum administered daily, every 4 hours 40 c.c. Total amount injected, 240 c.c. Death on fourth day in coma.

CASE 6.—R. R. CANNA, King's County Hospital, Brooklyn. Age 40. Rusty nail penetrated ball big toe. Mixed infection. Tetanus bacilli found. Period of incubation, 11 days; trismus, opisthotonos, unable to swallow; general convulsions, severe; treatment began on first day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum 2 injections, each 40 c.c. Total amount injected, 80 c.c. Death second day after admission.

CASE 7.—ROBT. W. JOHNSON, Maryland General Hospital, Baltimore, Md. Age 18. Slight laceration palm left hand and powder burn, blank cartridge. Period of incubation, 5 days; stiffness of jaws, gradually growing worse, dysphagia; entered hospital third day; general convulsions; treatment began third day; continued 3 days. Mulford's antitoxin used. Intramuscular injection of antitoxic serum administered daily, injections 20 c.c. each; third day one, and one every 4 hours for next 3 days. Total amount injected, 380 c.c. Death on sixth day.

CASE 8.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 28. Slough from burn, dorsum right foot; fell on stove during attack of epilepsy. No tetanus bacilli found. Period of incubation, 15 days; stiffness jaw muscles, gradually growing worse; general convulsions on second, fourth and fifth days; treatment began on second day; continued 16 days. Intramuscular injection of antitoxic serum administered daily, second, third, fourth, and seventh to sixteenth days 10 c.c. once daily into thigh muscles, sixth day 2 injections each 10 c.c. Total amount injected, 140 c.c. Recovery. Gradual improvement. Discharge on sixteenth day.

CASE 9.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 53. Punctured wound, foot. Rusty nail. Tetanus bacilli found. Period of incubation, 9 days; stiffness muscles neck, back; trismus moderate; rigidity muscles abdomen, back and neck; dysphagia; 1 slight convulsion; treatment began on second day; continued 6 days. Intramuscular injection of antitoxic serum, twice daily 60 m., increased to 70 m. twice daily deep into thigh. Total amount injected, 65 c.c. Death on seventh day.

CASE 10.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 42. Contused and encrusted wound, bridge of nose. Period of incubation, 6 days; stiffness jaw, increasing to pronounced trismus, marked delirium and restlessness, pain and difficulty in breathing; treatment began on second day; continued 6 days. Intramuscular injection of antitoxic serum, second day once, after this twice daily 10 c.c. deep into thigh. Total amount injected, 110 c.c. Death on seventh day.

CASE 11.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 40. End index finger cut off, sewed on and healed. Period of incubation, 10 days; stiffness jaws and neck; risus sardonicus; admitted fourth day of disease; treatment began on fourth day; continued 2 days. Intramuscular injection of antitoxic serum, on 4th day 30 c.c., on fifth day 20 c.c., deep into thigh. Total amount injected, 50 c.c. Death on sixth day.

CASE 12.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 25. Punctured wound, sole right foot, rusty nail, incised 24 hours later. No tetanus bacilli found. Period of incubation, 10 days; admitted fourth day with trismus, general clonic spasms; general convulsions; treatment began on fourth day; continued 3 days. Intramuscular injection of antitoxic serum fourth day 10 c.c. on admission, after this 10 c.c. three times daily deep into thigh. Total amount injected, 100 c.c. Death on seventh day.

CASE 13.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 18. Laceration, dorsal structures, left foot. Laceration great toe right foot. Amputation left foot and great toe of right foot within 2 hours after injury. No tetanus bacilli found. Period of incubation, 7 days; stiffness jaws and neck; general convulsions, rigid abdominal muscles; general convulsions; treatment began on first day; continued 5 days. Intramuscular injection of antitoxic serum, 20 c.c. daily deep into thigh muscles. Total amount injected, 100 c.c. Death on fifth day.

CASE 14.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 21. Punctured wound, outer side sole right foot. Period of incubation, 25 days; stiffness of jaws; this disappeared; cramps in abdomen, opisthotonos, no rigidity arms or legs; convulsions; general convulsions; treatment began on first day; continued 4 days. Intramuscular injection of antitoxic serum first day 50 c.c. into muscles of thigh; second day 60 c.c. into muscles of thigh; third and fourth days 20 c.c. into muscles of thigh. Total amount

injected, 150 c.c. No injections for 72 hours before death as there was apparent improvement. Then sudden death.

CASE 15.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 8. Superficial clean granulating wound left ankle, 5 cm. in diameter, no foreign body, no suppuration. Period of incubation, 8 days; dysphagia, rigidity muscles neck, trismus, rigid abdomen; general convulsions; treatment began on second day; continued 1 day. Intramuscular injection of antitoxic serum, 20 c.c. into gluteal muscles. Total amount injected, 20 c.c. Death third day in violent convulsions.

CASE 16.—C. A. PORTER, Massachusetts General Hospital. Age 40. Traumatic amputation of fingers; axe. No tetanus bacilli found. Period of incubation, 13 days; stiffness of jaw, backache, slight risus; T. 99.2°, P. 102, R. 26; general convulsions, one; treatment began on fourth day. Intramuscular injection of antitoxic serum, 10 c.c. into deltoid q. 4 hours. Recovery in 21 days.

CASE OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRACEREBRAL INJECTION.

CASE 1.—Rhode Island Hospital. Age 24. Punctured wound, foot; rusty nail. Period of incubation, 6 days; continued 1 day. Intracerebral injection of antitoxic serum, 1 injection. Death 2 days after admission.

CASE OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRAVENOUS INJECTION.

CASE 1.—C. A. PORTER, Massachusetts General Hospital. Age 52. Following operation for removal uterine polyp. No tetanus bacilli found. Period of incubation, 7 days; risus; symptoms severe; emprosthotonos; T. 100°, P. 84, R. 17; treatment began first day; continued 2 days. Intravenous injection of antitoxic serum, 30 c.c.—40 c.c. q. 4 hours. Convulsions followed each injection. Death 48 hours after admission.

CASES OF TETANUS TREATED BY SUBCUTANEOUS INJECTION OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

CASE 1.—R. H. TEDFORD; private. Age 14. Blank cartridge wound of hand improperly dressed. Period of incubation, 5 days; general convulsions ninth day; treatment began on ninth day; continued 19 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, twice daily for first 10 days, once daily thereafter. 50 c.c. Total amount injected, 1350 c.c. Effect of antitoxin doubtful. Chronic case. Recovery.

CASE 2.—F. F. SMITH; private. Age 24. Five-inch cut by buzz saw which had been cutting old wood. Period of incubation, 11 days; stiffness of left leg 3 days before any other symptom; treatment began on fifth day; continued 7 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 50 c.c. twice daily. Total amount injected, 700 c.c. Chronic case. Recovery.

CASE 3.—D. C. MORIATA; private. Age 14. Laceration of knee. Period of incubation, 18 days; stiffness of neck, jaw, face, and body; general convulsions seventh day; treatment began third day; continued 8 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 100 c.c. once daily. Total amount injected, 800 c.c. Improvement after fifth injection. Chronic case. Recovery.

CASE 4.—C. E. CAMPBELL; private. Age 30. Extensive laceration of hand by cannon fire-cracker. Period of incubation, 11 days; general convulsions

second day; treatment began second day; continued 16 days. Mulford's and N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 10 c.c. q. 4 to 6 hours. Total amount injected, 1460 c.c. Subacute case. Recovery.

CASE 5.—G. W. GREEN; private. Boy. Compound fracture of humerus under dirty conditions. Period of incubation, 6 days; general convulsions first day; treatment began first day; continued 4 hours. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 90 c.c. in divided doses. Total amount injected, 90 c.c. Very acute case. Death second day.

CASE 6.—H. E. PHELPS; private. Age 24. Slight cartridge wound of finger. Period of incubation, 8 days; general convulsions first day; treatment began first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 20–50 c.c. twice daily. Total amount injected, 170 c.c. Acute. Death on third day.

CASE 7.—F. R. CALKINS; private. Slight wound, palm of hand. Period of incubation, 5 days; general convulsions within 4 hours; treatment began second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. 1 injection. Total amount injected, 20 c.c. Acute. Death on third day.

CASE 8.—HENRY FIELDS; private. Age 35. Compound Pott's fracture. Period of incubation, 10 days; trismus; general convulsions early; not severe; treatment began first day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. 1 injection. Total amount injected, 20 c.c. Acute. Death on third day.

CASE 9.—FRANK H. FLOOD; private. Age 12. Laceration of great toe by bicycle. Period of incubation, 9 days; sore throat; general convulsions within 4 hours; treatment began on second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. at 1 injection. Total amount injected, 50 c.c. Acute. Death on second day, 3 hours after injection.

CASE 10.—L. S. MERRITT; private. Age 16. Toe crushed between cars. Period of incubation, 3 days; dysphagia; general convulsions within 12 hours; very severe; treatment began on third day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 30 c.c. at 1 injection. Total amount injected, 30 c.c. Acute. Death on third day.

CASE 11.—Period of incubation, 5 days; general convulsions 12 hours after onset; very severe; treatment began second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin 500 c.c. at 1 injection. Total amount injected, 500 c.c. Acute. Death on second day.

CASE 12.—J. B. CONANT; private. Boy. Penetrating wound, left palm, by cartridge. Period of incubation, 10 days; general convulsions second day; treatment began second day; continued 2 days. Mulford's and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, twice daily 10 c.c.—40 c.c. Total amount injected, 90 c.c. Death on eighth day.

CASE 13.—C. D. KLINE; private. Boy. Cartridge wound of hand with wad remaining in hand. Period of incubation, 8 days; general convulsions 8 hours after onset; very severe; treatment began on first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 20 c.c. once daily. Total amount injected, 40 c.c. Death on second day.

CASE 14.—W. W. TAYLOR; private. Age 65. Laceration of elbow in machinery. Period of incubation, 10 days; spasm of biceps of injured arm; general convulsions third day, not severe; treatment began fifth day; 1 injection. P. D. & Co.'s antitoxin used. Subcutaneous injection. Total amount injected, 30 c.c. Death on eighth day.

CASE 15.—M. B. DAVIS; private. Age 26. Crushed finger. Period of incubation, 8 days; stiff neck; general convulsions third day; severe on fourth day; treatment began on twelfth day; continued 6 days. N. Y. S. D. of H.'s antitoxin

used. Subcutaneous injection of antitoxin administered daily, each injection 30-50 c.c. Total amount injected, 300 c.c. Gradual recovery.

CASE 16.—PRIVATE. Cartridge wound of hand. Period of incubation, 8 days; stiff neck and sore throat; general convulsions within 48 hours; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 10 c.c. q. 12 hours. Total amount injected, 80 c.c. Death on fourth day.

CASE 17.—ALICE M. PERRIGO (head nurse), Mineola Hospital, Mineola, N. Y. End of finger crushed by hammer. Period of incubation, 10 days; possible convulsion on fifth day; treatment began on fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxin administered daily, 4 injections, each 20 c.c. Total amount injected, 80 c.c. Death on sixth day.

CASE 18.—JAS. H. MCGAN; private. Crushed foot. Period of incubation, 5 days; general convulsions 48 hours; severe. Mulford's antitoxin used. Death on fourth day.

CASE 19.—CORYELL CLARK; private. Childbirth. Period of incubation, 6 days; general convulsions 36 hours; severe; treatment began second day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 1 injection daily, 20 c.c.—80 c.c. Total amount injected, 170 c.c. Death on sixth day.

CASE 20.—GEO. S. SKIFF; private. Nail wound of foot. Period of incubation, 7 days; general convulsions third day; treatment began third day; continued 3 days. Subcutaneous injection of antitoxin, 400 units daily. Total amount injected, 2800 units. Death on seventh day. Antitoxin doubtful, possibly diphtheritic.

CASE 21.—L. C. GREEN; private. Nail wound of foot. Period of incubation, 7 days; general convulsions second day; severe; treatment began second day; continued 1 day. Subcutaneous injection of antitoxin, 2 injections, 20 c.c. each. Total amount injected, 40 c.c. Death on fifth day.

CASE 22.—C. I. REDFIELD; private. Age 6 months. Burn, second degree, on thumb. Period of incubation, 10 days; trismus; general convulsions ninth day; only a few; treatment began on fifth day; continued 4 days. Mulford's antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. once daily. Total amount injected, 80 c.c. Death on ninth day.

CASE 23.—CASSAR SMITH; private. Age 13. Lacerated wound, left knee. Malaise and trismus; general convulsions first day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered, 50 c.c. daily. Total amount injected, 100 c.c. Death on second day.

CASE 24.—W. L. CLARK; private. Age 39. Nail puncture of wrist. Period of incubation, 3 days; pain in back of neck, stiffness of neck, throat and jaw muscles; pain and contraction in wrist 2 days after injury; treatment began on first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered, 10 c.c. once daily. Total amount injected, 30 c.c. Recovery.

CASE 25.—W. A. LEONARD; private. Age 5½. Nail wound, left foot. Period of incubation, 7 days; sore throat, stiffness muscles of jaw, œsophagus and neck; general convulsions 48 hours; treatment began fourth day; continued 10 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin 20 c.c. q. 4 hours. Total amount injected, 560 c.c. Recovery.

CASE 26.—D. C. MORIATA, Saratoga Hospital, Saratoga Springs. Age 45. Crushed shoulder by machinery at tannery. Period of incubation, 6 days; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. three times daily. Total amount injected, 300 c.c. Death on third day.

CASE 27.—A. E. ILETT, Watertown City Hospital, Watertown, N. Y. Age 4. Compound fracture forearm. Period of incubation, 7 days; jerky muscles and opisthotonos; general convulsions 48 hours; treatment began on first day.

continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 3 injections 10 c.c. each. Total amount injected, 30 c.c. Death on second day.

CASE 28.—R. GERRAIS; private. Age 7. Wound of foot by broken glass. Period of incubation, 22 days; contracture of masseters; no general convulsions; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. 1 injection. Total amount injected, 50 c.c. Recovery. Prognosis would have been good without antitoxin.

CASE 29.—W. W. JAMIESON; private. Age 3 years, 10 months. Rusty nail-head perforated right side of head. Period of incubation, 4 days; treatment began on first day; continued 4 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 15 c.c.—50 c.c. twice daily. Total amount injected, 265 c.c. Death on fourth day.

CASE 30.—H. M. REINHARDT; private. Age 23. Old nail injury to foot. Period of incubation, 8 days; some trismus, slight pain back of neck; general convulsions fifth day; treatment began on fifth day; continued 5 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 90 c.c.—150 c.c. once daily. Total amount injected, 590 c.c. Recovery.

CASE 31.—ROBT. C. MEHNERT, German Hospital of Buffalo, N. Y. Age 16. Rusty nail wound right foot. History incomplete, admitted in convulsions; general convulsions probably quite frequent; chloroform used; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 2 injections 50 c.c. each. Total amount injected, 100 c.c. Death on following day.

CASE 32.—ADOLPH HOERR; private. Age 32. Nail wound, hand. Period of incubation, 6 days; marked local contraction of hand; general convulsions 39 hours after onset; treatment began on second day; continued 3 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin, 40–90 c.c. twice daily. Total amount injected, 400 c.c. Death on fifth day. Apparently hypostatic pneumonia.

CASE 33.—G. E. WALKER; private. Age 10½. Sliver in knee removed with unclean pocket-knife. Period of incubation, 12 days; general convulsions second day; treatment began fourth day; continued 6 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin 10 c.c. injected once or twice daily. Total amount injected, 100 c.c. Recovery. Case questionable.

CASE 34.—H. M. REINHARDT; private. Age 7. Lacerated wound sole of foot. Period of incubation, 14 days; general convulsions first day; treatment began on first day; continued 5 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. twice daily. Total amount injected, 400 c.c. Recovery.

CASE 35.—A. R. WARNER, Cohoes City Hospital, Cohoes, N. Y. Age 15. Cartridge wound base of fingers. Period of incubation, 8 days; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c.—100 c.c. daily. Total amount injected, 150 c.c. Death on second day.

CASE 36.—JOHN NUGENT; private. Age 60. Nail puncture left foot. Period of incubation, 9 days; general convulsions very mild on third day; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s and Mulford's antitoxin used. Subcutaneous injection of antitoxin, 40 c.c.—60 c.c. daily. Total amount injected, 100 c.c. Death on third day.

CASE 37.—CHAS. C. SWEET, Samaritan Hospital, Troy, N. Y. Age 28. Crushed right hand in corn husker. Period of incubation, 12 days; no general convulsions; treatment began on second day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. q. 6 hours. Total amount injected, 900 c.c. Recovery. Serum used locally.

CASE 38.—A. F. WRIGHT; private. Age 11. Abrasion on toe. Period of incubation, 13 days; general convulsions on sixth day; continued sixteenth

day. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin, 10 c.c.—40 c.c. for 5 injections. Total amount injected, 80 c.c. Recovery.

CASE 39.—F. E. LEWIS; private. Age 12. Clean cut on hand. Period of incubation 11 to 12 days; general convulsions; date questionable; treatment began on sixth or seventh day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. for 3 injections. Total amount injected, 60 c.c. Death on eighth or ninth day.

CASE 40.—CHAS. C. SWEET, Samaritan Hospital, Troy, N. Y. Age 28. Crushed right hand in corn husker. Period of incubation, 12 days; trismus and dysphagia; no general convulsions; treatment began on second day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 50 c.c. q. 6 hours. Total amount injected, 950 c.c. Gradual recovery.

CASE 41.—W. J. CARR; private. Age 34. Nail wound of foot. Period of incubation, 5 days; trismus; general convulsions on third day; treatment began on third day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 1 injection 50 c.c. Total amount injected, 50 c.c. Death on fourth day.

CASE 42.—H. W. SCHLAFFI, German Hospital, Buffalo, N. Y. Age 16. Contusion and laceration of leg. Period of incubation, 12 days; treatment began second day; continued 4 days. Subcutaneous injection of antitoxin, 50 c.c. daily subcutaneously; 50 c.c. daily deep into muscle. Total amount injected, 400 c.c. Death on fifth day.

CASES OF TETANUS TREATED BY INJECTION, INTO VARIOUS STRUCTURES, OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

CASE 1.—A. W. ELTING; private. Age 35. Abortion. Period of incubation, 8 days; trismus; general convulsions seventh day; treatment began on eleventh day; continued 6 days. P. D. & Co.'s, Behring and N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, eleventh to fourteenth days q. 6 hours = 10 c.c.; fourteenth to eighteenth days 8 injections; total, 1050 c.c. Intraspinal injection, subdural, 150 c.c. Total amount injected, 1200 c.c. Some sleep and rest after some of the injections. Subacute case, slow recovery.

CASE 2.—A. W. ELTING; private. Age 57. Nail wound of foot. Period of incubation, 10 days; pain and stiffness of jaws and neck; general convulsions third day; treatment began on second day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 450 c.c. = 6 injections. Intraspinal injection, lumbar puncture, 3 injections, 50 c.c. each. Total amount injected, 600 c.c. Improvement following use of antitoxin. Death in spasm on fifth day from arterio-sclerosis. Tetanus was not progressing.

CASE 3.—A. W. ELTING; private. Age 14. Nail wound of foot. Period of incubation, 7 days; trismus—marked local contraction injured leg third day; general convulsions third day; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections = 270 c.c., 20 c.c.—50 c.c. Intraspinal injection, 50 c.c., 1 injection. Total amount injected, 320 c.c. Some relief from subdural injection; none from subcutaneous. Death on fourth day.

CASE 4.—C. H. TRAVELL; private. Age 27. Punctured wound of foot. Period of incubation, 7 days; stiffness muscles face and jaw; general convulsions third day; treatment began on sixth day; continued 4 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections = 270 c.c. Intraspinal injection, 2 injections, 80 c.c. Total amount injected, 350 c.c. Marked improvement from subdural injection, subcutaneous no effect. Recovery.

CASE 5.—SHELDON VORHEES; private. Age 53. Burns, third degree, legs. Period of incubation, 17 days; trismus; treatment began first day; continued 8 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 12 injections = 10 c.c.—100 c.c. each. Intraspinal injection, 1 injection 100 c.c. Total amount injected, 840 c.c. Chronic case; poor general condition. Death on eighth day.

CASE 6.—W. J. CARR; private. Age 55. Traumatic amputation of toes by threshing machine. Period of incubation, 7 days; dysphagia and trismus; general convulsions fourth day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. twice. Intravenous injection, 100 c.c. Total amount injected, 110 c.c. Death on third day.

CASE 7.—R. M. VOSE; private. Age 45. Punctured wound of foot; nail. Period of incubation, 10 days; general convulsions 28 hours after onset; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 2 injections, 20 c.c. and 30 c.c. Intraspinal injection, 1 injection 30 c.c. Total amount injected, 80 c.c. Death in 65 hours.

CASE 8.—F. J. PARMENTER and ROSWELL PARK; private. Age 9. Tack wound of foot. Period of incubation, 7 days; stiffness in neck; general convulsions third day; treatment began on second day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection. Intraneural injection, 30 c.c. Intraspinal injection, 1 injection. Total amount injected, 80 c.c. Death on third day.

CASE 9.—A. VANDERVEER; private. Age 8. Compound fracture of forearm, penetration of bone into dirt of lawn. Period of incubation, 5 days; pain in injured arm and trismus; treatment began on first day; continued 1 day. Subcutaneous injection of antitoxic serum, 50 c.c.—100 c.c. Intraspinal injection, 50 c.c. Total amount injected, 200 c.c. Death on second day.

CASE 10.—A. VANDERVEER, Albany City Hospital, Albany, N. Y. Age 6. Cartridge wound right hand. Period of incubation, 7 days; trismus; general convulsions; under chloroform most of time; treatment began second day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c. Intraspinal injection, 30 c.c. Total amount injected, 80 c.c. Death on second day.

CASE 11.—MARSHALL CLINTON; private. Age 24. Compound comminuted fracture right femur. Period of incubation, 5 days; general convulsions first day; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c.—50 c.c. Intraspinal injection, 10 c.c. Total amount injected, 100 c.c. Death on third day.

CASE 12.—A. GILBERT; private. Age 20–22. Thrown from train, long wound right calf. Period of incubation, 6 days; general convulsions first day; treatment began first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c.—100 c.c.—100 c.c. Intraspinal injection, 7 c.c. of 25 per cent. $MgSO_4$ solution. Total amount injected, 250 c.c. +. Death on third day.

CASE 13.—JOHN W. RILEY; private. Age 26. Crack in left thumb. Period of incubation, 11 days; spasm of masseters and neck muscles; general convulsions second day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c., 50 c.c., 70 c.c., 50 c.c. Intraspinal injection, 50 c.c. Total amount injected, 250 c.c. Death on second day.

CASE 14.—MARSHALL CLINTON; private. Age 14. Wound of foot with pitchfork. Period of incubation, 12 days; stiffness of jaw and neck; general convulsions second day; treatment began second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 14 injections, 50 c.c. each. Intraneural injection, 5 c.c. Intraspinal injection, 5 c.c., 6 c.c. Total amount injected, 716 c.c. Recovery.

CASE 15.—R. O. CROISER; private. Age 38. Punctured wound of foot.

Period of incubation, 6 days; stiffness of jaw and neck; general convulsions second day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 4 injections, 10 c.c. each. Intraneural injection, 10 c.c. Total amount injected, 50 c.c. Death on third day.

CASE 16.—W. J. CARR; private. Age 10. Pistol shot wound index finger. Period of incubation, 5 days; general convulsions first day; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Intraneural injection, 8 c.c. Intravenous injection, 40 c.c. Total amount injected, 48 c.c. Death on second day.

CASE OF TETANUS TREATED BY INTRACEREBRAL INJECTION OF
ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE
DEPARTMENT OF HEALTH.

CASE 1.—H. W. NASH; private. Boy. Cartridge wound of hand. Period of incubation, 7 days; general convulsions 7 hours, very severe; treatment began second day; continued, 2 injections. N. Y. S. D. of H.'s antitoxin used. Intracerebral injection of antitoxin administered daily, 2 injections 5 c.c. each. Total amount injected, 10 c.c. Death in convulsion, second day.

THE TREATMENT OF TETANUS BY MAGNESIUM SULPHATE.

BY JOSEPH A. BLAKE, M.D.,

OF NEW YORK.

THE treatment of tetanus by magnesium sulphate was suggested by the discovery, by Dr. S. J. Meltzer, of the marked action of this salt, when applied to nerve-tissues, in inhibiting both afferent and efferent impulses.

Although similar effects can be produced by subcutaneous or intravenous injections, they are accompanied by symptoms due to the depressing effect of the drug upon the higher centers, both in the medulla and cerebrum. The action on the medulla produces slowing of respiration and finally death by paralysis of the respiratory center.

In lumbar injections into the subdural space, the drug acts directly upon the nerve-trunks at the site of injection, as is evidenced by paralysis of motion and sensation in the lower extremities, and as it diffuses itself upward along the cord, the paralysis extends to the trunk and upper extremities, diminishing, however, in intensity as it progresses.

Absorption of magnesium sulphate from the spinal canal is fairly slow, and definite action upon the nerve-trunks may be obtained while the general effects upon the higher centers may not manifest themselves for several hours or may be wholly absent. In fact, Meltzer has found that the magnesium sulphate may be removed from the spinal canal by puncture and washing, after the desired local effects have been obtained, and the undesirable action upon the higher centers wholly prevented or stopped, if already commenced. On the other hand it has been demonstrated by Dr. Teague, in experiments carried out in the Surgical Research Laboratory of Columbia University, that the drug is, to a certain extent, cumulative in its action.

* Read before the American Surgical Association, Cleveland, Ohio, June 1, 1906.

For instance, a dose insufficient in itself to produce symptoms when injected into the peritoneal cavity of guinea-pigs, will produce death when repeated at the end of twenty-four hours. In the treatment of tetanus, the dose is ordinarily repeated and this fact should be borne in mind.

Meltzer found that one cubic centimeter of a 25 per cent. solution of magnesium sulphate to every twenty-five pounds bodyweight was sufficient, when injected into the spinal canal, to produce in most cases anæsthesia to the surgical degree from the neck down. As reported in a former paper,¹ I have found a marked variation in the effects of the drug,—for instance, a similar amount per pound of bodyweight produced no anæsthesia and very slight motor-paralysis in one patient, while in another its action was most profound, producing unconsciousness which lasted nineteen hours and paralysis of motion and sensation persisting for over forty-five hours. Age and sex seem to have a direct bearing upon its action and in the same paper I made the following statement: "As far as can be learned from our present experience, children are quite susceptible, and women more so than men. The dose for a child should probably never exceed one cubic centimeter for every twenty-five pounds bodyweight, the dose for a woman should not be less, while the dose for a male adult should probably not be less than a cubic centimeter for every twenty pounds." In the treatment of tetanus, the dose usually has to be repeated and consequently may be corrected, so the uncertainty in regard to its effect is not so important as it otherwise might be. While uncertainty as to its effects might contraindicate its use for the less dangerous conditions, tetanus is attended by such a great mortality that we are justified in using anything that promises to be beneficial.

It is unfortunate that we are unable to derive much information from experimental work with animals, since the anatomical peculiarities preclude intraspinal injections except in monkeys. Dr. Teague has found that intraperitoneal injec-

¹ Jour. Surg., Gyn. and Obstetrics, May, 1906.

tions in guinea-pigs produce little or no effect on the convulsions in induced tetanus unless a lethal dose is given. For instance, if a local tetanic spasm of a limb is induced by the injection of tetanus toxine, it cannot be controlled by an intraperitoneal injection of magnesium sulphate unless in excessive doses.

From our experience in human tetanus, we know that intraspinal injections relieve spasm, so that we must infer that it produces a block of nerve-impulses by direct action on the nerve-trunks. So far, its employment in human tetanus has not been attended by uniform results. This fact may be due to different degrees of susceptibility on the part of the patient and partly by variations in technique or lack of experience in the use of magnesium sulphate on the part of the medical attendant. As far as I can ascertain, only four cases of tetanus have been treated with magnesium sulphate. The first was treated by myself at the Roosevelt Hospital and this together with a case treated by Dr. F. H. Markoe at the New York Hospital, are reported in full by me in the *Journal of Surgery, Gynecology, and Obstetrics* for May, 1906. Since then, the report of two other cases by Dr. Samuel Logan, of New Orleans, has appeared in the *Journal of the American Medical Association* for May 19, 1906. In addition to these four cases of tetanus, a case of miliary tuberculosis, with symptoms closely resembling those of tetanus, has been treated by me and is interesting in demonstrating the effect of the drug upon the convulsions. Of these patients, only one has recovered, namely, the first patient treated by myself.

A detailed report of these cases in the present paper would require too much time, and I consequently limit myself to a statement of my deductions derived from the study of them. In my patient, a case of acute tetanus in a boy fifteen years of age, starting in a wound of the hand, we were either very fortunate in hitting upon the correct dose or else the patient was peculiarly susceptible to the action of the drug. There is not the slightest doubt in my own mind, or in the minds of those who observed the patient, that the drug had a very

marked effect in inhibiting the convulsive seizures, relieving pain and producing rest. For instance, the patient at the beginning of the treatment was in a condition of practically constant opisthotonos, with rigid scaphoid abdomen and well-marked trismus. Rest and nutrition were impossible. The effect of magnesium sulphate was to produce complete relaxation of the muscles of the trunk and the extremities and considerable relaxation of the muscles of the jaw, so much so that the patient rested quietly and could swallow easily.

The injections controlled the convulsions in this patient for periods varying from twenty-nine to thirty-seven hours each. At the latter part of these periods the convulsions would begin to return and gradually increase in severity until they reached a point when it was deemed wise to give another injection. No injurious effects were noted in this patient except that throughout the treatment there was, as might be expected, paralysis of the bladder. The dose was the same as recommended by Dr. Meltzer for the production of anæsthesia. At the time the injections of magnesium sulphate were stopped, the patient was running along with the symptoms we would expect in an ordinary case of chronic tetanus. At one time, six days after the last injection of magnesium sulphate, the convulsions became more severe and magnesium sulphate was given again with similar effect. Before commencing treatment with magnesium sulphate in this patient, he was given several injections of tetanus antitoxine, one of them into the cervical cord with no apparent effect.

My impressions from observing this patient were that with the aid of magnesium sulphate we were able to keep up nourishment and strength, so that his vital forces could control the disease, and that in reaching this control the injected antitoxine was probably a great aid. According to Norris, death in tetanus may occur in a convulsion and be due to asphyxia or spasm of the heart, or, on the other hand, in about half the cases it is due to exhaustion. Exhaustion may be caused by excessive convulsions and by lack of nourishment. In such cases, judging by our experience in the case just reported,

magnesium sulphate will be a great help. There are, however, a certain number of cases of tetanus which die in the first few days of the disease and which die in a condition of asthenia which can hardly be attributed to exhaustion from convulsions or from lack of nourishment. In these cases death seems to be due to a depressing action of the toxins, and magnesium sulphate would probably be of no benefit. Dr. Markoe's case is an example of this class. In this case a moderate dose of magnesium sulphate was given fifteen hours after the initial symptoms of the disease, with only a slight effect upon the convulsions, the patient dying thirteen hours later, the entire illness lasting twenty-eight hours. There were no symptoms referable to an overdose of magnesium sulphate.

In Case I, reported by Dr. Logan, death occurred at the end of the fourth day of the disease with symptoms of heart failure and hyperpyrexia. Two injections of magnesium sulphate were given. The first, about forty-one hours before death, produced complete relaxation even of the jaws, and relieved the pain completely for over twelve hours. The tonic spasm then returned rapidly in the trunk and extremities. Eighteen hours after the injection the general spasm was marked and there was twitching on attempting to swallow. The second injection was given twenty-four hours after the first and again produced complete relaxation, which lasted until his death, sixteen hours later, with the exception of a general convulsion induced by giving an enema two hours after the last injection of magnesium sulphate.

This patient's condition although somewhat improved by the first injection, grew progressively worse after the second. There was excessive bronchorrhea, the respirations were rapid and shallow, the heart's action feeble. The respiration was not slowed as is usually the case with large doses of magnesium sulphate.

An analysis of the treatment in this case is noteworthy. The patient was a boy eleven years of age; the bodyweight was estimated at eighty pounds. On the first day of the disease he was given fifty cubic centimeters of antitetanic serum

by lumbar puncture. In the thirty-six hours preceding the injection of magnesium sulphate he had received 170 grains of chloral and 450 grains of bromide without effect upon the convulsions. Both injections of magnesium sulphate were given under general anæsthesia. Fifty cubic centimeters of antitetanic serum were given at the same time with the first injection. The duration of the first anæsthesia was forty minutes, of the second, thirty-five. Possibly the large doses of chloral may have depressed the heart's action and that together with the ether may have caused the bronchorrhea. It is not necessary to give an anæsthetic to perform lumbar puncture, and one of the advantages of magnesium sulphate is that it produces sufficient anæsthesia for redressment of the wound. The dose of magnesium sulphate was large, one cubic centimeter of the 25 per cent. solution for every twenty pounds at the first dose, and one cubic centimeter for every twenty-four pounds bodyweight at the second dose. Possibly its action may have been cumulative, inasmuch as the dose was repeated in twenty-four hours. The action of the second dose was, certainly, very profound.

In the second case reported by Dr. Logan there was absolutely no result from the use of magnesium sulphate. The patient was a woman, twenty-four years of age, and received a dosage corresponding to one cubic centimeter for every twenty-five pounds bodyweight. The first injection producing no result, it was followed, seventeen hours later, by another, the patient dying of failure of respiration in a tetanic seizure a short time afterward. Although this last was a severe case, there should have been some result, and the failure of the magnesium sulphate is apparently another instance of the unreliability that has been demonstrated in its use for producing anæsthesia.

In the case of general miliary tuberculosis resembling tetanus already mentioned, magnesium sulphate was quite efficient in controlling the convulsions and was repeated nine times in eight days, once with an interval of only thirteen hours, without producing untoward symptoms.

My impression of the drug is that although we cannot be certain of its effect, yet it is reasonably safe and offers us a means of modifying the convulsions and relieving pain in a way no other drug has approached. For these reasons alone it is worthy of a more extended trial. It is not a specific treatment, but it produces anæsthesia, which may be taken advantage of for intraneural or other injections of tetanus antitoxine and for revising the site of the infection.

EARLY OPERATION IN TRAUMATIC INTRACRANIAL HÆMORRHAGE.*

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THE extreme gravity of hæmorrhage of the intracranial vessels is universally recognized, and the necessity of early interference as affording the only relief to this condition is generally accepted by surgeons, yet there are still a number of cases allowed to die from want of operation. The object of this paper therefore, is to suggest a more frequent resort to exploration of the skull in the hope of thereby saving cases which otherwise would result fatally. While no doubt recovery is possible under expectant treatment, it is equally true that many more die from want of operation, and some observers state that over ninety per cent. die under expectant treatment. Not infrequently one reads in the medical journals reports of cases which could have been saved by operation, and it is the experience of surgeons connected with the large hospitals to observe at times autopsies which reveal the fact that early resort to trephining would have been followed by success.

The failure on the part of the surgeon to operate in these cases may be ascribed to several reasons. It may be due to the extreme difficulty, or impossibility, of arriving at a diagnosis; and it must be conceded that very often from the absence of a history of the injury or from the presence of existing complications, a positive diagnosis cannot be made, and accordingly expectant treatment is indicated. It must be said, however, that inquiry into the history of a case previous to having been seen by the surgeon is at times incomplete and that a more thorough investigation reveals a history

* Read before the New York Surgical Society, April 25, 1906.

of trauma sufficient to justify exploration. In other cases, from the history of the injury and from the fact that symptoms of severe compression followed an apparently slight degree of trauma, the surgeon suspects or diagnoses severe contusion or laceration of the brain, and accordingly considers operation useless. The diagnosis of cerebral contusion or laceration, and especially its extent, is more or less conjectural, unless the nature of the injury is such as to allow inspection of the brain. And it is from the opinion so often expressed by surgical writers that subdural hæmorrhage is usually accompanied by cerebral contusion, that an expectant attitude is advised in this variety of intracranial hæmorrhage. It is a fact, however, that operation (or autopsy) has shown that cerebral contusion is by no means so frequent as is supposed, and in many instances death was solely due to compression of the brain by the blood-clot. Some authorities also do not consider the presence of contusion accompanying hæmorrhage as contraindicating operation, and in the opinion of others the removal of the blood-clot has a beneficial effect upon the complicating contusion of the brain.

The absence of focal symptoms, even when the symptoms of general and increasing cerebral compression are present, is considered by some surgeons sufficient reason for desisting from operation, as information is lacking as to where the trephine should be applied. Perhaps this may apply in a few cases, but in the great majority of cases where there is a definite history of trauma, a careful examination of the scalp will reveal a contusion or abrasion which will supply the desired guide.

Another cause which bears on the question of diagnosis (and this applies mostly to the general practitioner) is the indefinite and confused idea which prevails concerning the condition known as cerebral concussion. In the average surgical text-book one reads that there may be a light degree or a severe degree of concussion and, consequently, the patient lies unconscious for a period varying from a few moments to several days. Again, we read, if the symptoms last for days,

then the diagnosis of concussion must be excluded, and some severe intracranial injury is to be suspected. If it were remembered that the symptoms of pure cerebral concussion are transient in character and that many so-called cases of severe concussion are in reality cases of compression, it would result in an earlier recognition of the condition, which at times demands early interference, and the cases would accordingly reach the surgeon while there was still a chance for relief. While perhaps a more careful inquiry into the history of trauma might lessen the difficulty of diagnosis, it would seem that the suspicion of existing cerebral contusion and also the absence of focal symptoms are not sufficiently valid reasons for desisting from operation.

Hæmorrhage may follow injuries of the various intracranial vessels, but the one most frequently involved is the middle meningeal artery, next the vessels of the pia, and finally the venous sinuses of the dura. The extent of the hæmorrhage, as well as the rapidity of its formation, depends upon the size of the injured vessels, and the result of the hæmorrhage is a diminution of the space in the cranial cavity and a corresponding degree of cerebral compression. Hæmorrhage from the trunk or a large branch of the middle meningeal artery is followed by the formation of a steadily-increasing clot which finally interferes with the entire cerebral circulation, and death follows. Should, however, the clot not be large enough to cause a high degree of intracranial tension, but of sufficient size to cause persistent pressure, it is equally dangerous, as the continued pressure causes œdema of the brain and thus adds to the increasing compression.

The symptoms of traumatic intracranial hæmorrhage are those of cerebral compression, and the main indication of treatment is the removal of the clot causing the pressure on the brain; at the same time ligation of any blood-vessels exposed by the operation.

Intracranial hæmorrhage is divided into the extradural and subdural varieties, according to the location of the clot regarding the dura, and it may be of interest to consider some

points in regard to these varieties of hæmorrhage, and in addition to report the history of some cases.

I. *Extradural Hæmorrhage*.—This variety of hæmorrhage is caused most frequently by rupture of the middle meningeal artery, less frequently by injury of the pial vessels, and occasionally by an injury of the venous sinus. Rupture of the middle meningeal artery generally occurs in connection with the fracture of the vault or base of the skull and in the majority the violence is produced by a blunt object. Should the fracture be a comminuted one, the artery may be injured by a splinter of bone or cut by the edge of a fragment. In the case of a simple fissure crossing the course of the artery, the vessels may be cut by the sharp edge of the bone which is depressed at the time of fracture; or the vessel lying in a groove is ruptured at the time the bone is fractured. The artery, owing to its greater want of elasticity, may however be ruptured without any accompanying fracture of the skull.

Of infrequent occurrence, but of importance as regards diagnosis, is the fact that the artery may be ruptured on the side of the skull opposite to that on which the violence was inflicted.

The clinical picture of rupture of the middle meningeal artery varies accordingly as the hæmorrhage takes place externally or is confined between the dura and the bone. When occurring with compound comminuted fracture, the blood may escape externally between the fragments, and the symptoms then are those of free hæmorrhage. More frequently, however, the blood from the injured vessel extravasates between the skull and the dura, detaching the latter from the bone and forming a hæmatoma, usually of good size, which exerts pressure on the underlying brain.

The symptoms of rupture of the middle meningeal artery are those indicative of general intracranial pressure, such as disturbances of consciousness, changes in the pulse and respiration, and combined with these general symptoms are those indicating local pressure of the motor area with which the artery is so closely related. The arm centre of the motor area

is the one most commonly affected, but not infrequently there may be complete hemiplegia of the opposite side of the body.

An important symptom, and by some considered as characteristic of rupture of this artery, is the so-called free or lucid interval: the interval of consciousness which precedes the signs of compression. The interval may or may not be preceded by loss of consciousness due to the shock of the injury. While its duration varies, it generally lasts but a few hours—possibly a day—and in extremely rare cases three or four days.

When the blood escapes externally, the diagnosis of rupture of the artery is easy, but in intracranial hæmorrhage it is more difficult, and to operate successfully, one must not only determine the presence of the hæmorrhage, but locate its site, if possible. As given in the text-books, the principal symptoms upon which a diagnosis may be based are the lucid interval, especially if it be of short duration, the hard, slow pulse (so-called pressure pulse), stertorous respiration, together with the signs of gradually-increasing hemiplegia. If, in addition to these, there are present at the point of injury a fracture, a contusion, or even an abrasion of the scalp, then the diagnosis is certain. Such a combination of distinct and characteristic symptoms, however, is unusual, and often the clinical picture is incomplete or complicated with symptoms of accompanying brain injuries.

As an example of the difficulties in arriving at a positive diagnosis, is the history of the following case:

CASE I.—W. N., 45 years of age, admitted to the New York Hospital on August 24, 1902, at 10.30 P.M.

History.—While slightly intoxicated, fell down stairs, striking on the back of his head. He was picked up somewhat unconscious and brought by ambulance to the hospital. The accident occurred half an hour previous to admission. On admission the patient was deeply unconscious; there was no reaction to irritation such as supraorbital pressure; loss of corneal reflex, pronounced exophthalmos, right pupil somewhat dilated, left pupil contracted,

full stertorous respiration (20 per minute), a bounding pulse much above normal, rate 110; no fascial or other paralysis could be determined; knee-jerk slightly increased; no ankle clonus. Careful examination of the scalp revealed a spot of œdema about the size of a dollar behind and above the right ear. The patient rapidly grew comatose, the exophthalmos increased, both pupils dilated, pulse grew more rapid and irregular, and death followed about three hours after admission.

Autopsy.—Save for a slight hepatic cirrhosis the viscera were healthy. Cranium: above and behind the right ear an ecchymotic spot, beneath which was an oblique fissured fracture about $1\frac{1}{2}$ inches long. On opening the skull, the cranial cavity on the right side was found occupied by an extradural hæmorrhage extending from the groove of the anterior branch of the middle meningeal artery backward over the occipital region, the clot measuring six inches by three inches, and one and three-quarters of an inch in thickness. The posterior branch of the middle meningeal was completely ruptured at a point directly beneath the fracture. The brain was distorted by compression of the clot, the ventricles almost completely collapsed. Otherwise the brain was entirely normal.

This case was diagnosed by the ambulance surgeon as one of alcoholism, and the patient was admitted to the medical wards, but the house physician recognized it as a case of cerebral compression. Owing to the pronounced exophthalmos, and from the fact that severe symptoms of compression followed quickly after a slight degree of tremor, he suspected that some grave intracranial lesion was present, most likely a severe laceration or contusion of the brain, and operation was considered useless. Autopsy, however, revealed the fact that the brain was uninjured and the sole cause of death was due completely to the hæmorrhage. This case is a good illustration of the fact that the diagnosis of cerebral contusion is more or less conjectural, and the autopsy revealed a condition of affairs which could have been met successfully by an explorative operation. The indications for operation were well marked, in that there was a history of trauma, a localized

contusion of the scalp at the site of violence, and the symptoms of a rapid and steady increase of intracranial pressure.

In addition to this case, the history of another which came lately under my care, may be of interest.

CASE II.—J. K., 25 years of age, messenger boy, was admitted to the New York Hospital on March 1, 1906, at 3 o'clock, A.M.

History.—Fifteen hours previous to admission the patient was thrown from a wagon to the pavement, striking on the back of the head. He was not rendered unconscious, but simply a little dazed, got up at once and went about his work for the rest of the afternoon. In the evening he complained of headache, which steadily increased so that he could not sleep, and he applied for admission to obtain relief from the pain.

Admission.—Over the external occipital protuberance there is a small, shallow scalp-wound, and on enlarging it, it was found to not involve the pericardium. No bony irregularity or depression could be felt. Pupils equal and react normally; reflexes normal; no sensory disturbances or motor paralysis. Pulse 84, temperature 100, respiration normal. General condition good. Patient is rather pale in appearance, and complains bitterly of occipital headache. Antiseptic dressing applied to the wound, and hypnotics ordered. On the following day the patient's condition remained practically the same, except that a slight degree of opisthotonos was noted. During the following night there was a free hæmorrhage from the scalp wound, which somewhat relieved the headache. On March 3 the opisthotonos was well marked. No paralysis or sensory disturbances were observed; the chief complaint was still the severe headache. The pulse was somewhat diminished in frequency, rather irregular in force, and the sphygmomanometer showed a decided increase in arterial pressure. The blood-pressure at 10.30 A.M. was 190 mm.; 2.30, 214 mm., and at 7.40 P.M. 240 mm. In the evening examination of the right fundus showed the presence of a choked disk. During the night the wound again bled rather freely, and the patient slept at intervals. On March 4 the patient was quieter, complained less of headache and appeared to be more comfortable. It was noticed, however, that he was rather dull and apathetic. The

blood-pressure at 9.40 was 206, at 12.40, 208, and at 3.45, 212 mm. In the afternoon the pulse was more irregular in force and frequency than at any time before. At 6.40 P.M. the patient suddenly became unconscious and stopped breathing. Artificial respiration was resorted to and practiced for about six-and-a-half hours. During this time the patient made no effort to breathe. Spinal puncture taken at this time showed a clear fluid under no tension. The pulse became slower and weaker and finally very irregular. Some slight twitching movements were noticed on the right side of the face shortly before death, which occurred at 1.30 A.M. on March 5th.

Autopsy.—Nothing abnormal about viscera. Head: a small wound in the median line just back of the occipito-parietal suture. The scalp of the entire occipital region is infiltrated with blood; skull-cap thin, mesocephalic. Dura thin, non-adherent, but abnormally tense. Tension uniform on both sides. Internal surface smooth and glistening. A small amount of blood is found beneath the dura on the right. Occipital meninges on the right side are infiltrated with blood; convolutions of convexity markedly flattened. Base of brain shows a slight contusion on the under surface of the right frontal lobe and on the anterior surfaces of the temporo-sphenoidal lobes. Basal vessels normal. Right occipital lobe posteriorly and the posterior portion of the right lobe of cerebellum are markedly flattened. Base of skull: a large epidural blood-clot is situated in the posterior fossa on the right side extending up to the occipito-parietal suture, but not beyond the median line. This clot occupies an area about the size of the palm of the hand, and at its thickest portion measures about $1\frac{1}{4}$ cm. Corresponding to this clot there is a fracture extending from the right occipito-parietal suture near the median line downward and backward into the posterior fossa and terminating 2 cm. to the right of the foramen magnum. Aside from the slight contusions previously noted the brain is normal.

This case contains many points of interest, one of which is a lucid interval lasting four days. Usually the duration of the interval in extradural hæmorrhage is limited to a few hours, and it is extremely rare to find an interval lasting as long as it did in this case. Its explanation may be due to the

location of the fissured fracture in a region where the branches of the artery are of small size, and the hæmorrhage was thus a gradual one. The relief afforded to the patient by the bleeding from his wound, however, is very significant, and most probably the intracranial pressure was thus lessened, lengthening thereby the duration of the lucid interval.

The most prominent subjective symptom was the severe headache which was mainly confined to the occipital region and marked by frequent exacerbations of pain, so that the patient would cry out. This was particularly noticeable on the second and third days following the injury; on the fourth day the headache had diminished and the patient expressed himself as feeling comfortable. The sudden paralysis of the respiratory centre without previous disturbance of consciousness is very unusual, as the order of succession of the centres affected is the reverse of what we have been taught. Generally the cortex is the centre first affected by pressure, and the pons and the medulla are the last. During the four days the patient was under observation, there was nothing abnormal about the respiration both as to rate and character, and the paralysis of the respiratory centre was sudden and not preceded by cyanosis. The pulse was never very slow, the lowest being 54 in the afternoon of the third day, when there was some irregularity in tension. On the morning of the following day the irregularity had increased, but the tension was lower. The presence of disturbances of sensibility, such as contralateral anæsthesia or hyperæsthesia is mentioned by some observers as indicating hæmorrhage from the posterior branch of the middle meningeal artery, but in this case of posterior hæmatoma these symptoms were absent.

As to the diagnosis of the case the positive determination of hæmorrhage was never possible, but in the afternoon of the fourth day, some four hours before the sudden paralysis of the respiratory centre, I suspected that there was hæmorrhage and decided to explore the skull, but before doing so requested the house surgeon to have a neurologist examine the patient and obtain his opinion. My reasons for exploration were the

history of trauma, diminution of the headache, the fact that the man seemed rather dull, and finally the presence of a choked disk. In addition, the increase in irregularity of the pulse, together with its increased tension, added to my suspicions. The neurologist did not see the patient until two hours after the onset of respiratory paralysis, and the time of his visit was during the period of artificial respiration. From the history of the case and the sudden cessation of breathing he diagnosed a hæmorrhage into the fourth ventricle. The result of the autopsy revealed a condition of affairs which in all probability could have been satisfactorily treated by operation, and the fatal ending was due to cerebral compression from hæmorrhage.

In reviewing the history of the case while under observation, it will be recognized that there was a well-marked and increasing cerebral compression in the presence of choked disk, and an increase in blood-pressure as shown by the sphygmomanometer, but with these symptoms there was no interference with consciousness and the rational condition of the patient up to the time of the respiratory failure rather misled me. The case shows that well-marked cerebral compression is possible without interference with consciousness.

The value of the presence of a choked disk, as indicating compression, as well as the assistance of the sphygmomanometer to ascertain the degree of blood-pressure, is well illustrated in the present case; and in several later cases I have always relied upon the examination of the fundus and the use of the sphygmomanometer in determining the presence and degree of cerebral compression. The postponement of operation until the neurologist's opinion could be obtained resulted in the loss of a favorable opportunity.

An occasional cause of extradural hæmorrhage is a wound of one of the venous sinuses of the dura, and of these the superior longitudinal and the lateral sinus are the ones most frequently injured, and they are also those most easily reached by the surgeon. As a rule the injury is associated with fracture of the skull and is due to perforation by a bony splinter

or from the sharp edge of a fragment of bone. In other cases the sinus may lie in the path of some foreign body penetrating the skull from without, such as a bullet; or during an operation the sinus may accidentally be wounded by a chisel or a trephine. Owing to their want of elasticity and from their firm attachment to the skull the walls of the sinus do not collapse when wounded, and accordingly it increases the free disposition to hæmorrhage and diminishes the chances of a spontaneous arrest of the same.

As regards the diagnosis, the nature of the injury may be suspected when there is a free venous hæmorrhage of the wound located over the course of the sinus; should there be no chance for escape of the blood, it extravasates between the skull and dura, producing symptoms of increasing cerebral compression. The symptoms of compression, however, come on slowly, owing to the low blood-pressure in the sinus, and focal symptoms are usually absent. When associated with simple comminuted fracture, the blood may also extravasate between the skull and pericranium, forming a hæmatoma of increasing size, as the following case well illustrates:

CASE III.—A girl, 11 years of age, fell through a skylight, striking on her head on the floor below, a distance of some ten feet. She was stunned for a few moments, and on coming to, noticed that her nose was bleeding. A physician was called and on examination found nothing beyond a contusion of the forehead. During the following two days there was frontal headache and a swelling of the forehead gradually increasing in size. On the third day, as she was rather morose and apathetic, her parents brought her to the Out-patient Department of the New York Hospital. Over the median line of the frontal region, just at the edge of the hair, there was observed a semi-fluctuating swelling about the size of a hen's egg. An incision into it was made by the examining surgeon, and after evacuating a good-sized hæmatoma under the pericranium, a depressed fracture of the underlying bone was discovered. The wound was packed with sterile gauze and the patient sent into the hospital for operation. On admission the girl seemed rather dull and inclined to sleep, but

would respond to questions. There were no motor or sensory symptoms. Pulse 88, temperature 100, respiration 22. On the following day, under ether, the fracture was exposed through a crucial incision. It was found to be a comminuted depressed fracture of the frontal bone, situated a little anterior to the junction of the sagittal and coronal sutures. There was a circular area of depression about one-and-a-half inches in diameter and almost a half inch in depth at the centre, from which the separate fractures ran out radially. The depressed bone was composed of five fragments, and from the lower end of the depression, a little to the right and parallel with the median line, was a fissured fracture running toward the base of the skull. With an elevator one of these depressed fragments was removed and a very profuse venous hæmorrhage set in from beneath the edge of an adjoining fragment. Quickly removing the latter, it was seen that the hæmorrhage came from a hole about one-eighth of an inch in diameter in the wall of the superior longitudinal sinus. The bleeding was controlled by pressure with the tip of the left index-finger, while the remaining fragments and a large extradural blood-clot were removed. The clot, about two inches in diameter and extending both sides of the median line, was removed by means of pledgets of gauze, combined with gentle irrigation. A sterile gauze compress, half an inch square and made up of several thicknesses, was then substituted for the finger over the sinus wound, and over the compress was packed a short strip of inch-sterile-gauze. The wound was partially closed by suture and a firm sterile dressing applied. On recovery from the anæsthetic the child was placed in an upright position in bed. The postoperative history was uneventful. Three days after operation the strip of gauze packing was removed; on the fifth day the compress over the sinus was removed. There was no recurrence of hæmorrhage, and the wound was rapidly covered with healthy granulations. On the tenth day it was noticed that whenever the child coughed, or blew her nose, small quantities of pus appeared at the lower part of the wound. On inserting a probe, it passed into a sinus leading downward for two-and-a-half inches, but no bare bone could be detected. The suppurating sinus was drained with gauze, and in no way interfered with the rapid healing of the wound. The effect of the operation on the child's disposition was quite marked,

in that her previous moroseness and apathy were followed by brightness and activity. Six weeks after the operation she was discharged with the wound healed and no symptoms of any serious effect of the injury upon the brain.

In this case the sinus was wounded by a sharp edge of one of the depressed fragments, probably the second one, as the location of the wound of the sinus corresponded exactly with the centre of the depressed area, where the edges of the fragments were sharply pointed. The absence of a scalp-wound is to be noted, as it is rather rare, since compound fractures of the skull usually accompany wounds of the superior longitudinal sinus. This accounts for the extravasation of blood between the pericranium and the skull and the gradually increasing swelling in the frontal region. Although a good-sized extradural clot existed, it was from the ability of the blood to extravasate outside of the skull that the intracranial pressure was not increased sufficiently to cause definite symptoms of cerebral compression. The main reason for seeking advice at the hospital was the gradual increase in the size of the swelling at the forehead, together with the change in the child's disposition. The physician in charge of the case previous to admission made a diagnosis of concussion and prescribed nerve tonics. This is merely mentioned as an example of the mistaken ideas which many general practitioners entertain concerning the question of cerebral concussion.

An interesting feature is the ease with which the hæmorrhage at the time of operation was controlled. The opening in the wall of the vessel was large enough to allow of serious hæmorrhage and until controlled by the finger it was most profuse, but with the finger during operation, and the gauze packing subsequently, the complication was readily met. As a rule, pressure is sufficient to control the bleeding from an ordinary wound of the sinus, but should it be necessary to cut through the vessel in the course of an operation, then ligation is necessary. Suture of the wound of the vessel and the application of arterial clamps have been successfully used, but in

my opinion—unless the wound be a very large one—gauze packing will do as well and is a much simpler method. It has the disadvantage of leaving an open wound, thus increasing the chances of infection, but with ordinary antiseptic precautions this danger is very small.

The appearance of pus on the tenth day at the lower edge of the wound after the girl had coughed or blown her nose, led us to suspect that the infection was due to the fissured fracture extending either into the frontal sinus or nasal cavity. This suspicion was strengthened by the discovery with the probe of a narrow sinus leading down to the base of the skull. It should be remembered also that there was epistaxis following directly after the fall. Fortunately, infection did not interfere with the wound healing, and the danger of a suppurative phlebitis was lessened by the presence of healthy granulation covering the wound of the sinus. As the dura at operation was found uninjured, and there were no symptoms at any time indicating brain injury, it is most likely that the results of the fall were limited to a fracture of the frontal bone and a wound of the underlying superior longitudinal sinus; and probably the future prognosis of the case is good.

II. *Subdural Hæmorrhage*.—Subdural hæmorrhage most frequently follows injuries of the vessels of the pia mater, less frequently a rupture of the middle meningeal artery, and occasionally an injury of a venous sinus.

When the blood extravasates into the subdural space, the anatomical conditions are more favorable for the formation of a diffuse hæmatoma, but frequently at operation the clot is found to be circumscribed, resembling the form characteristic of extradural hæmorrhage.

The etiology of subdural hæmorrhage corresponds entirely with that of extradural hæmorrhage. The symptoms are those of cerebral compression, and its clinical picture resembles so closely that of extradural hæmorrhage that, as a rule, a differential diagnosis is impossible. The lucid interval which has been emphasized by many observers as a characteristic symptom of rupture of the middle meningeal artery is also characteristic of subdural hæmorrhage.

In Vol. 59 of Guy's Hospital Reports, Bowen reports seventy-two cases of traumatic subdural hæmorrhage collected from American and British sources which he has systematically studied. These cases have been divided into Class A and Class B, the former being cases of pure compression by blood-clots and not attended with contusion or laceration of the brain, the latter (B) in which compression has been complicated by the presence of lacerations and severe contusions, which were the cause of death. In sixty of the seventy-two cases there was an interval of consciousness previous to the appearance of the symptoms of compression. Bowen considers the period of lucidity which has hitherto been emphasized in relation to extradural hæmorrhage, as of equal importance in subdural hæmorrhage.

As regards the duration of the free interval, one is impressed when reading this article with the long period which may elapse before signs of compression appear. In the greater number of instances it was over twenty-four hours, and the longest interval was twenty-seven days. The duration of the free interval is, therefore, an important point in differentiation, and should the interval be one of days, instead of hours, it indicates subdural hæmorrhage. Should, however, the lucid interval be absent, a differential diagnosis is impossible.

The course of subdural hæmorrhage is generally more protracted. Cases are reported where patients, who had been unconscious for weeks, gradually regained consciousness and made a good recovery. On the other hand, very rapidly developing cases have been observed.

The compression symptoms may be general or local, and in the presence of the latter operative interference is indicated. Should, however, the general symptoms show an increase of intracranial pressure, operation is also indicated. But it is in cases where the general symptoms are those indicating a stationary condition of pressure and where focal symptoms are absent, that the surgeon may be in doubt whether to operate. It must be remembered, however, that in these cases of protracted coma, interference should not be postponed too long,

as the persistency of pressure is equally dangerous, since it favors œdema of the brain and thus increases compression. Should the patient recover without operation, cortical atrophy may result, together with degeneration of the lateral columns of the spinal cord.

The following case is an example of the difficulties which may confront the surgeon in arriving at a decision to operate:

CASE IV.—K., 21 years of age, bartender, admitted to the medical side of the New York Hospital in the morning of April 14, 1903. He was said to have fallen in a fit thirty-six hours previous to admission, and had remained unconscious ever since. On admission the patient was unconscious, but roused to resist irritation. There was an œdematous swelling of the scalp about one inch in diameter over the right parietal eminence. No signs of depressed bone. Slight subconjunctival ecchymosis of the inner canthus of the right eye. The pupils were normal and reacted. Respiration 20, pulse 72, temperature 100. No symptoms of anæsthesia or motor paralysis; neck rigid and slightly tender; knee-jerk exaggerated; spasticity of legs; plantar reflex normal, no ankle clonus; heart and lungs normal; abdomen retracted; leucocytes 11,600; urine sp.g. 1028; no sugar or albumen, few hyaline casts; blood-pressure 170 mm. Spinal puncture, no increase in spinal pressure. Spinal fluid diffusely blood-tinged and on microscopic examination showed a few blood-cells, a few leucocytes, no organisms. In the evening temperature was 101.6, pulse 84. April 15, patient very restless all night; still unconscious. Temperature 102.4, pulse 84, blood pressure 182 mm. There is definite, but not absolute loss of power in the left lower extremity; no paralysis of face or left arm. Patient sent to the operating-room.

Operation.—Large horseshoe flap, turned down from right parietal region, exposed a fissured fracture of the skull which could be traced forward to the orbital margin and backward to be lost in the occipital bone. At a point located approximately over the upper part of the right motor-area, there was a slight depression of the lower edge of the fracture. Trephine was applied at this point, and a button of bone about one inch in diameter removed. No comminution of the inner table was found—no epidural clot;

the dura rather dark-colored, tense and not pulsating, bulged into the trephined opening. With rongeur forceps the opening was increased to about two inches in diameter. The dura was opened through a crucial incision and a good-sized clot exposed. This was gently removed, and some dark, bloody serum, containing lacerated brain tissue, followed. After carefully sponging the cortex, there was seen a cavity extending into the brain about half an inch and large enough to admit the tip of the index-finger. The brain still bulged into the wound and prevented complete suture of dura. The scalp wound was sutured with silkworm gut up to its convexity, where a small rubber tissue drain was inserted. Mild stimulation was necessary after operation. On April 16th and 17th patient remained unconscious and there was a free discharge of bloody serum from the wound, necessitating frequent changes of dressing. On April 18th patient answered questions, but was dull. On April 19th full consciousness was regained and patient said he had been struck with a sand-club during a fight. On April 25th sutures were removed from the convexity of the wound, and on slightly retracting the flap a small hernia of the brain was discovered. On May 10th hernia had principally disappeared, and on May 22d wound was entirely healed. On June 2d patient was discharged cured. In the following autumn he had epileptic seizures, rather mild in character and at intervals of two weeks. Under the use of bromides they have disappeared, and he has had but one seizure during the past year.

In this case the history of trauma was purposely concealed and, accordingly, the patient was admitted to the medical wards of the hospital. Careful examination having excluded all medical cause of the coma, surgical advice was requested. At my visit, on April 14th, as the history of trauma was still wanting, expectant treatment was advised, but on the following day, after diligent inquiry among patient's friends, it was ascertained that he had had an altercation. On my second visit, on April 15th, having ascertained this fact, I advocated immediate exploration of the skull. Although the symptoms of general compression had not increased and there was still absence of focal symptoms, the correctness of my advice was

proved by the operation. The presence of great intracranial pressure was a striking feature of this case at the time of operation, when the brain pressed into the trephine opening after the evacuation of the clot. This intracranial pressure continued for some days after operation, as is evidenced by the prolapse of the brain at the trephine opening found on the tenth day after operation.

The successful result in this case was due in a great measure to the removal of the clot, but the free drainage of bloody serum following the operation contributed in a great degree to keep the intracranial pressure within the desired limit.

As mentioned above, the main reason for advising operation was the history of trauma, and had I known at my first visit that the patient had been struck with a club, I should have advised immediate exploration of the skull. The epileptic convulsions which appeared after the operation were most likely the result of the cortex laceration or, maybe, due to adhesions between the scalp and the cortex, as the dura was not completely sutured. In view of the improvement, however, which has attended the use of bromides, further surgical interference is at present not indicated.

Up to within a few years the treatment of subdural hæmorrhage has, as a rule, been purely expectant, but the opinions concerning the advantages of the operation have since changed. Contusion of the brain is not so frequent an accompaniment as was formerly supposed, and in the opinion of some its presence is not only not a contraindication, but by removal of the clot the cerebral circulation is improved and thus a beneficial influence is exerted on the accompanying contusion. The results of operation have been satisfactory, and the percentage of recoveries rather large. Of the seventy-two cases collected by Bowen, there are twenty-eight of recovery and forty-four deaths. Twenty of the fatal cases were not operated on for various reasons, such as mistaken diagnosis, suspicion of brain contusion, etc. Thus there were fifty-two cases operated on with twenty-eight recoveries, and

over fifty per cent. of the operations were successful. A rather significant fact, and one which suggests that the results might have been better, was that in ten of the twenty non-operated cases death was due solely to compression from hæmorrhage, a condition favorable for operation. Bowen's statistics also show that contusion of the brain was an accompaniment in only one-half of the cases in his collection. Finally, the injurious effect on the cortical centres and on the spinal cord of the long-continued pressure should not be forgotten, and unless it is promptly relieved the patient is very liable to be left with permanent lesions.

As regards the more frequent resort to exploratory operation in the treatment of traumatic intracranial hæmorrhage, it would seem that it is clearly indicated. While surgeons are united as to the necessity of the operation in injuries of the middle meningeal artery, which practically are the sole cause of extradural hæmorrhage, they are still doubtful as to the adoption of a similar treatment in cases of subdural hæmorrhage. This view is inconsistent, in that it is only rarely that the symptoms are sufficiently characteristic to allow of a differential diagnosis, and very frequently it is only by exploration that the source of the hæmorrhage is ascertained. The result of hæmorrhage, whether it be extradural or subdural, is always compression of the brain by the clot, and the sole indication of treatment is removal of the clot, and checking the hæmorrhage. The important point for the surgeon is to recognize the presence of intracranial hæmorrhage and if the symptoms of compression are severe, to immediately relieve the compression, no matter what may be the source of the hæmorrhage.

While an advocate of resorting more frequently to operation, with the idea that thereby we will save many cases otherwise doomed, I am not in accord with those who advise that the skull should be opened in every doubtful case.

REPORT OF A CASE OF TUMOR OF THE CAROTID BODY.*

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THE first person to suspect the existence of the carotid body seems to have been the great Haller; and from his time on there has now and then been a suggestion by some anatomist of a knowledge of the presence of the structure. In 1833 Mayer gave a description of it and pointed out its common situation in the bifurcation-angle of the carotid artery. He described it as about the size of a grain of rice, and as attached to the carotid vessel; and mentioned some other facts in relation to it. Luschka, in the early 60's, made a microscopic study of the gland; and since that time, Arnold, Kölliker, and others have written about it.

One thing seems to be sure: that the carotid body is not invariably present. In fact, it is frequently absent. Funke¹ points out that it is enclosed in a fibrous capsule, and that a fibrous band comes from the capsule and divides the body into two parts, other bands from the capsule separating each half into lobules. This fibrous tissue contains a multitude of blood-vessels. Funke further points out that the lobules contain cell-collections without definite arrangement, that only rarely do they resemble the structure of a gland, and that in all parts of these lobules blood-vessels are demonstrable. The same observer believes that the lobules result from proliferation of the endothelial cells of the blood-vessels.

To-day, we should describe the carotid body as a structure placed in the bifurcation of the common carotid artery; to the inner side of this vessel, on a lower level than the bifurcation;

* Read before the Philadelphia Academy of Surgery, May 7, 1906.

¹ Am. Med. July 16, 1904.

or on the posterior surface of either the external or the internal carotid. It probably always takes origin from the sheath of the internal carotid. In human beings, it is frequently absent. At least it is frequently absent in those beyond puberty. It is encapsuled in fibrous tissue, is fastened to the sheath of the internal carotid, and the gland with its capsule is embedded in a considerable amount of fat. In shape, it is oval; in color, reddish brown. Its size when not enlarged is about that of a grain of corn. The septa from the capsule divide the organ into follicles, or cell-balls; and these cell-balls are composed of numbers of endothelial cells and capillary blood-vessels. A small branch, several branches, or many branches from the carotid pass into the carotid body; and the carotid plexus of the sympathetic nerve is in very close relation with the body. This structure has been studied, of late, by John Funke, Paltauf, Reclus, Marchand, and others. Its function is unknown.

Occasionally tumors arise in this structure; and Dr. Funke, in the previously-quoted article, has collected fifteen cases. In his series, it is shown that the tumors may occur in adolescents or in adults, and in either sex. He quotes the observation of Heinleth that the carotid body undergoes development until puberty, when it ought to atrophy; but that if it fails to atrophy, but continues to grow, a tumor forms. Such a tumor grows very slowly, requiring years to reach any considerable size, and never becoming very large. Sooner or later, however, rapid growth is liable to begin; and it is usually only after years of growth, and when this sudden rapidity of growth has alarmed the patient, that a surgeon is called in.

Early in the case the growth is entirely free from pain, but in the later stages there may be pain in the tumor, pain radiating into the ear, dysphagia, and—as has been pointed out—perhaps pupillary contraction of the same side and facial vasomotor disturbance. In a large majority of the reported cases, there has been distinct transmitted pulsation in the tumor. The skin is movable over the growth; the tumor may be moved from side to side, but not up and down; and there is usually a systolic murmur over the tumor.

I have recently had, in the Jefferson College Hospital, a case of this rare and interesting trouble, and a diagnosis was made before operation. The record of the case is as follows:

The man was 52 years of age. Over twenty years ago he noticed a very small lump on the right side of his neck. He said that when he first found it this lump was not larger than a grain of corn. During many years it slowly but certainly increased in size. A few months ago it began to grow rapidly, and within less than a year of rapid growth it attained the size of a small egg of a hen. He also began to have some difficulty in swallowing, had attacks of redness of that side of the face, and occasionally suffered from pricking pain in and around the tumor. The rapid growth alarmed him, and he decided to consult a surgeon.

An examination showed the tumor to be in the superior carotid triangle, having its lower border on a level with the upper margin of the thyroid cartilage, and its upper border passing to about the level of the angle of the jaw. The external jugular vein was distinctly visible passing over it. The skin was freely movable over the tumor; and the tumor itself was movable from side to side as though on a hinge, but was not movable from above downward or from below upward. The growth was not tender on handling, but was the seat of very marked pulsation, which investigation demonstrated not to be expansile pulsation, but a lifting of the growth by the pulse of the carotid. The tumor was hard, but somewhat elastic, being, however, softer at some points than at others. It was smooth, but apparently lobulated on the surface. On listening with the stethoscope, a systolic murmur could be made out when the stethoscope was pressed firmly upon it; but this was not more manifest than it was on the carotid artery itself, when the same maneuver was executed.

It was evident that this tumor was not an aneurysm, from its long history, from its hardness, from the absence of genuine bruit and expansile pulsation, and from the fact that pressure on the artery did not cause the mass to diminish in size. It was not a cyst, because it was evidently a solid body. The question of a misplaced fragment of thyroid tissue was considered; but the density, the history, and the vascular phenomena led to the rejection of this idea. It was too hard and too deep for a fatty tumor. Its movability, its long history, and the phenomena

of pulsation were against sarcoma; and the long history, without any change in consistency and without the involvement of the overlying parts, was considered to rule out lymphatic glandular trouble.

I advised operation, on account of the rapid growth then taking place and the apparently inevitable disaster, if this rapid growth were permitted to continue unchecked.

After having exposed the tumor by an incision at the anterior margin of the sternocleidomastoid, and while endeavoring to free it, I was greatly embarrassed by the profuse bleeding. The fatty tissue about the tumor and the capsule of the tumor oozed continuously from numberless places. The bleeding was both arterial and venous. Forty ligatures failed to arrest the bleeding.

After exposing the tumor thoroughly, the growth was found to be in and around the angle of bifurcation of the common carotid; and it embraced the vessels so completely that it was out of the question to free the growth from them as I had hoped to do and as was done in 3 reported cases. It was equally impossible to abandon the operation, because the persistent hæmorrhage barred such a road of retreat. Consequently, the operation was proceeded with.

The common carotid artery was tied with two ligatures below the growth, and was divided between the ligatures. The distal stump of the divided artery was grasped with forceps, and used as a handle in lifting the tumor while the growth was being separated. The tumor, with the beginnings of the internal and external carotid arteries, was freed from its attachments. During this separation the internal jugular vein was badly torn; and it was necessary to ligate it. When the portion of the external carotid artery above the tumor was reached this vessel was tied and divided. Between the upper border of the tumor and the base of the skull there was barely room to ligate the internal carotid; it was with great difficulty that it was ligated and divided, and I barely escaped the accident met with by Mikulicz, who found the tumor had entered the bony foramen and was obliged to cut away bone to stop bleeding. The wound was closed with drainage.

The man had lost much blood and was considerably shocked. He reacted but slowly from the anæsthetic. Eight hours after the operation he developed a weakness just short of complete paraly-



FIG. 1—Case XXVI.



sis of the left arm and leg, the face escaping. He was also found to have a very low and extremely hoarse voice. The day after the operation, the voice continuing low and hoarse, the throat was examined; and relaxation and œdema of the right vocal cord were observed by Dr. J. Leslie Davis to exist. These conditions were due to paralysis of the cricothyroid muscle from injury of the superior laryngeal nerve.

For many days there was a copious flow of mucus from the larynx and the bronchi; and, owing to the anæsthesia of the mucous membrane, the patient had great difficulty in expelling this mucus. For some time there was considerable difficulty in swallowing, probably also due to injury of the superior laryngeal nerve, which, it will be remembered, also goes to the inferior constrictor of the pharynx. For the first few days after the operation there was a copious flow of lymph from the wound, showing that large lymphatic vessels had been divided. This ceased about the end of the first week.

On the eighth day after operation complete hemiplegia suddenly developed. The left arm and leg were completely paralyzed; the face was much drawn; and the man was dull, drowsy, and sometimes stuporous, but never unconscious. It was the opinion of Dr. Alfred Gordon that this attack was due to embolism, in all probability in the internal capsule; and the first and milder attack was thought to have been due to thrombosis in the cortical vessels.

The day after the onset of the hemiplegia, the man was found to be suffering severely with dyspnœa and repeated choking fits, in some of which it seemed that he must strangle. Great quantities of mucus passed into the throat, and there was the greatest possible difficulty in ejecting it. Examination of the left lung, made by Dr. John C. DaCosta, Jr., developed the fact that at least half of the lung was in a state of complete collapse, containing no air whatever. The right lung was entirely normal. The patient stated that he had had an exactly similar pulmonary condition a number of months before. This had come on from an unknown cause, and had almost killed him. The atelectasis produced great discomfort for a number of days, but was gradually recovered from; and the lung is now normal, so far as physical signs indicate. It seems probable that the laryngeal anæsthesia was responsible for this condition,

and that either plugs of mucus had passed into the lung and blocked the bronchi, or that some elements from the food had passed the larynx.

Present Condition (8 weeks after the operation).—A marked, but fading, left hemiplegia exists. The man can move the leg, and can stand upon his legs, if he supports himself with a cane or a crutch. He can move the elbow, the shoulder, and the wrist, and can flex the hand; but the extremity is still very weak. He has occasional paroxysms of violent shooting pain in the arm and in the leg. The wound is completely healed and not tender. The voice is hoarse and low, and the right vocal cord is œdematous and relaxed; and Dr. Davis is of the opinion that this is due to injury of the superior laryngeal nerve.

Conclusions.—It is thus seen that the operation of removing a tumor of the carotid body is a very formidable one. The surgeon may have to tie all the carotid arteries; and he may damage a nerve or nerves, with subsequent unfortunate results. The ligation of the common carotid artery is an extremely dangerous procedure; and it is one of the few operations in which the mortality does not seem to have been greatly diminished since the days of Sir Astley Cooper, who did the first successful ligation of the common carotid, in 1808. Mr. Richard Barwell, in his article on Aneurysm in "Ashhurst's International Encyclopedia of Surgery," published in 1889, gives the mortality of 107 cases of ligation of the common carotid for aneurysm as 25.23 per cent. Some more modern authors estimate the death-rate as in the neighborhood of, or over, 30 per cent.; and it is thus seen what a responsibility it is, even at the present time, to tie this vessel.

The danger of death is, however, not the only danger in ligating the common carotid. My case shows that hemiplegia may follow the operation. It has long been known that a considerable percentage of those on whom ligation has been performed suffer subsequently with cerebral symptoms. In some of the cases, these symptoms have been produced by thrombosis; in others, by embolism; and in still others, by cerebral softening. Pilz has pointed out that 32 per cent. of the cases



FIG. 2.—Case XXVI. Section.



in which the common carotid has been ligated exhibit brain symptoms, and that 56 per cent. of the cases that show brain symptoms die. Zimmermann says that in 11 per cent. of the cases there is softening of the brain, and that 26 per cent. of the cases show brain symptoms. There is much greater danger of brain symptoms when the operation is performed on the elderly or middle-aged than when it is done on the young. In older subjects, arterial atheroma may interfere with the distension of certain vessels whose integrity is necessary to bring sufficient blood from the vertebrals, from the other internal carotid, and from the terminations of the external carotids. Failure in a satisfactory restoration of circulation is most liable to occur when profuse bleeding greatly lowers the blood-pressure, as it did in this case. When such cerebral change ensues, it does not necessarily mean death. In fact, it may be recovered from, partially or completely. Usually, however, the condition is permanent and progressive, and finally results in death. In Funke's series of 15 cases of tumor of the carotid body, there were but two deaths; one from bronchopneumonia, and one from secondary hæmorrhage. There may be added to this, Keen's unreported case, which makes three deaths in 16 cases. In Funke's series, there was but one case of hemiplegia. In Dr. Hearn's case, however, which is not recorded in the table as one of hemiplegia, the patient died two months later; and Dr. Hearn tells me that, although he did not see the case, he believes from what he has learned that the man died of cerebral softening. So, out of 13 recoveries in Funke's cases, to which my cases may be added, making 14 recoveries, there were two cases of hemiplegia and one of cerebral softening.

Owing to the great danger in ligating the common carotid, surgeons have sought to avoid it in removing carotid tumors. The reported cases show that almost always all the carotids must be ligated. Albert, in his case, was obliged to ligate only the external carotid, being able to remove the growth from the carotid sheath. In his case the growth recurred within one year. In Heinleth's case and in that of Cuneo, no ligations were necessary, owing to the free separability of the tumor.

Out of Funke's 15 cases, only three are recorded as not requiring ligations of all the carotids; and when Keen's case and mine are added to this list, they make 17 cases, in 14 of which ligation of all the carotids was necessary.

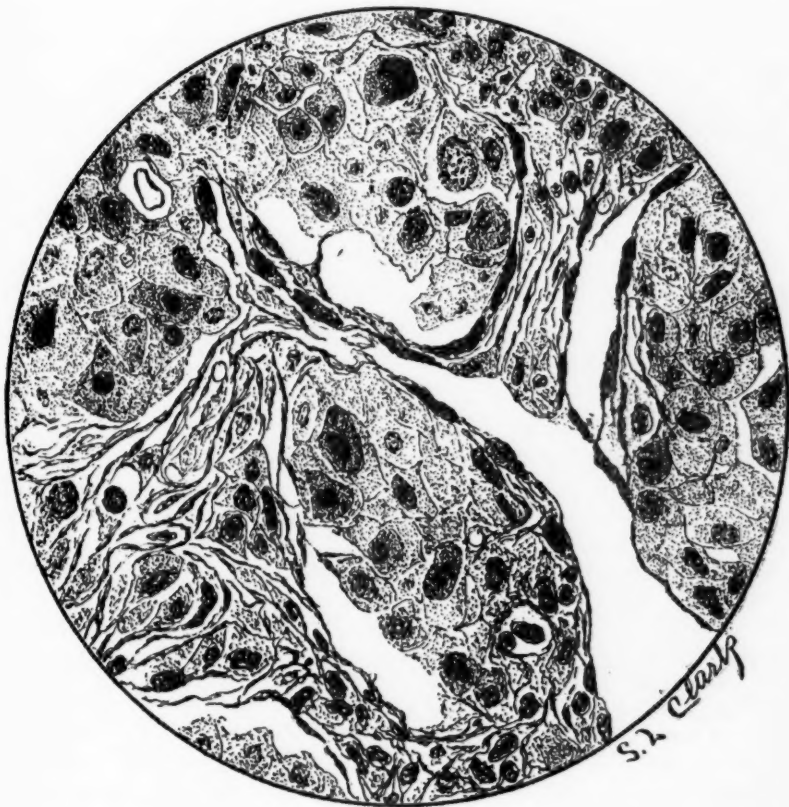
Another danger of the operation is nerve-injury. In my case, the superior laryngeal was injured. In all probability, it is a piece of this nerve that we find incorporated in the specimen. In Funke's 15 cases, there were six cases in which the nerves were injured—the sympathetic, the pneumogastric, the hypoglossal, the facial, or the recurrent laryngeal. Two cases out of the 15 exhibited postoperative paralysis of the vocal cord of the side operated upon.

It is thus evident that the operation of removing a carotid tumor is an extremely dangerous one, and is not to be lightly undertaken. We agree with Reclus that one should not touch these growths, unless they are productive of danger to life. So long as they are merely slowly progressing, they had better be let alone. It is only when they begin to grow rapidly that one should remove them, and then he must, in spite of the danger. In my case, the tumor was infiltrating the surrounding structures, and would unquestionably have killed the man, if allowed to remain. Surgeons must be wide awake to the existence of such growths. Without carefully examining every tumor in this region of the neck, one could easily be led into operating with a light heart for some supposedly trivial condition, and then find oneself suddenly so far advanced in attacking a carotid tumor that retreat would be impossible, and probably all the carotids would have to be tied. The diagnosis is possible in many cases. It was made in several of the cases in Funke's list, and it was made in the case now reported. The pictures exhibit the tumor that I removed, and Dr. Funke's report of the specimens follows:

Macroscopic Description.—The specimen is a lobulated mass, measuring 5 by 5 by 4 cm.; weight 104 gmm. It is dark red in color, encapsulated, distinctly elastic in consistency at some places and flabby at other places. The mass is irregular; it is composed of three large nodules, each being 2.5 cm. in one diameter and 2 cm. in the other. The smaller

nodules present do not attain a diameter of 0.5 cm.; they are especially seen on the anterior surface. This surface contains many depressions varying from 0.5 to 1 cm. in depth; these depressions are incident to the pulling of the capsule into the tumor substance. The lacerated tissue present adds to the irregularity of the anterior surface. The posterior surface is less irregular; it is lobulated, however, and the nodules are more conspicuous here than upon the anterior aspect. Laceration and

FIG. 3.



fragmentation of the capsule is marked. Lying upon this surface, not more than 2 cm. from the margin, is a greyish-pink cord-like piece of tissue apparently made up of smaller cords; the consistency and the architecture of this structure resemble a nerve. It is not firmly attached to the tumor-mass. Lying upon this surface, but only near one end, is a large vessel which from its general structure appears like the common carotid artery and which contains, 0.5 cm. from the free margin, a liga-

ture. One centimeter above the ligature the vessel divides; one branch curves slightly toward what was described as the anterior surface and then tunnels the mass between two of the nodules described. Only 0.5 cm. of this branch is visible, but upon dissection it is found to traverse the mass nearly parallel with the anterior surface and but 0.7 cm. from it. The other vessel curves slightly backwards and then tunnels the mass near the opposite side of the specimen, but runs parallel and very close to the

FIG. 4.



posterior surface. Both vessels are easily identified at what is presumed to be the superior portion of the tumor, and both vessels as well as the common carotid artery are firmly attached to the tumor mass. The first vessel described in all probability was the external carotid, since it gave off a small branch near its point of severance.

Dissection showed that the three larger nodules mentioned are firmly united at a point posterior to the bifurcation of the vessel mentioned. The one nodule is united to the other two at this point and along the

entire margin of but one nodule by means of a pedicle; the internal carotid passes between these nodules and is anterior to the pedicle. The other two nodules are for the most part situated in the fork formed by the branching vessel. Dissection also reveals that the smaller nodules are produced by the septa which penetrate from the capsule into the underlying tumor mass.

The cut surface has a lobulated appearance; it is granular, reddish-brown in color, but traversed by greyish bands; some of these bands are dense and comparatively broad. The cut surface as well as the capsule contains many small opened-mouthed blood-vessels; so numerous are they the surface has a porous appearance.

Portions of the tumor were fixed in Zenker's fluid and the remainder was preserved in Kaiserling's fluid. Sections were made and stained with hæmatoxylin and Van Gieson's method for connective tissue, by Mallory's reticulum stain and with polychrome-methylene blue.

Histology.—One margin of the sections is covered by a dense capsule composed by wavy fibrous connective tissue, in which are few lymphoid and spindle-shaped cells and few strands of elastica, together with many blood-vessels. From the capsule fibrous septa penetrate the underlying tumor-mass and divide it into lobules, which are again divided into alveoli. The fibrous septa are very broad and are found in cross and in longitudinal sections; they contain few lymphoid and spindle-shaped cells and large and small blood-vessels. Many of the last-named structures contain erythrocytes, and possess well-formed and thick walls.

The walls of the alveoli are in some instances formed by delicate connective-tissue strands, evidently constituents of the septa already mentioned; the greater number, however, are formed by delicate capillaries, branches of the vessels found in the septa. Occasionally these capillaries are composed of a single layer of endothelial cells; in other instances the endothelial lining is supported by a few strands of fibrous connective tissue. The alveoli are fairly uniform in size and very difficult to outline in many places, owing to the number of contained cells. The cells in the alveoli vary somewhat in size, ranging from 15 to 25 microns in diameter; they are irregular in outline, many are polyhedral and few are oval. The protoplasm contains no cell membrane; it is finely granular and acidophilic. The nuclei are comparatively large and intensely basophilic. The nuclear membrane is conspicuous. Occasionally few red blood-cells are found among the tumor-cells. In not a few alveoli the tumor-cells show degenerative changes. Few chromaffine cells are present.

Diagnosis.—Endothelioma; this is the type of tumor to which most writers on the neoplasms of the carotid gland apply the term "perithelioma." From the fact that the growth has invaded the vessels and the surrounding tissues it should be looked upon as malignant.

SHORTENING OF THE ROUND LIGAMENTS BY SUBPERITONEAL VENTRO-APONEUROTIC FIXATION.¹

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IN common with other favorite procedures in pelvic and abdominal surgery the operation about to be described for holding the uterus in a forward position attained its present stage of perfection through a process of surgical evolution, in which the ingenuity of Gilliam and Ferguson proved originating forces, while the fertile brain of a Simpson, and the surgical judgment and operative skill of a Montgomery played the parts of modifying factors. Now while the recognition of the operation by the name of its originator, compounded by the names of those who eliminated its original defects and improved and simplified its technic, may be of interest as a matter of surgical history and reflect the glory of those to whom credit is due, it must be admitted, that the practice of thus naming surgical innovations has no value scientifically, and, as many of us know, proves highly confusing to the student, hence the designation of the procedure as indicated by the title of this paper.

Shortening of the round ligaments by subperitoneal ventro-aponeurotic fixation, signifies in a few words the main anatomic and surgical features of a procedure that is again directing the attention of the profession to the feasibility, as well as the advisability, of replacing the retro-deviated uterus in suitable cases by restoring and enhancing the physiologic efficiency of its natural supports.

The principles underlying this comparatively new

¹ Read before the Philadelphia Obstetrical Society, March 1, 1906.

operation have gained in favor with many surgeons and not a few in their eagerness to pose as originators have described devious routes and complicated methods for the accomplishment of practically the same thing—*i.e.*, fixation of the inner third of the round ligaments to one or more of the ventral structures immediately above the pubic bone by subperitoneal transition.

The operation as finally perfected by Professor Montgomery and extensively practiced in the wards of the Jefferson Medical College Hospital for more than two years is simple in detail, and after mastering its technic is as easily and readily done as a ventro-suspension. The abdomen is opened and coexisting complications are dealt with as may be indicated. If the uterus is retrodisplaced and a forward inclination is desired, each round ligament about one-and-a-half inches from its uterine attachment is picked up and temporarily held with catch forceps; a strand of strong cat-gut fifteen to eighteen inches in length is passed beneath each ligament at these points, thus forming loops in which the ligaments rest while the two ends of each strand are secured by hæmostats. The round ligament of one side is next seized with a hæmostat immediately external to the part held by the looped strand, and this is handed to an assistant with instructions to render the distal portion of the ligament with its peritoneal investment tense by traction toward the median line of the abdomen. Both ends of the corresponding looped strand are now drawn through the eye of a Deschamp ligature-carrier. The peritoneum overlying the anterior leaflet of the broad ligament immediately below the hæmostat held by the assistant is picked up with a toothed-forceps and button-holed with a scissors, and through this opening the armed carrier is introduced, passing outward between the folds of the broad ligament following the course of the round ligament. Upon reaching the abdominal wall the tension hæmostat is removed while the point of the carrier is thrust through the abdominal musculature and aponeurosis about three-fourths of an inch above the margin of the pubic

bone and about one-and-a-half inches from the median line. The ends of the strand are now released from the eye of the carrier external to the aponeurosis and the carrier itself is withdrawn. Traction upon the strand breaks the peritoneal investment of the ligament held by its loop and drags it to the under surface of the aponeurosis through which it is teased by enlarging the perforation with the spreading points of a scissors. The round ligament of the opposite side is next dealt with in a like manner. The exposed portion of each round ligament overlying the abdominal aponeurosis is now under the control of the will of the operator for shortening or lengthening either its proximal or distal portion, the same as might be done with the exposed loop of a tendon by sliding same within its sheath. After securing the necessary tension of both ligaments for holding the uterus in a median forward position, the proximal side of each loop is sutured to the abdominal aponeurosis to the extent of about three-fourths of an inch. The traction strand is withdrawn following the fixation of each ligament. The abdominal opening may be closed in accordance with the choice of the surgeon.

The crescentic abdominal incision, including the skin, fat, and aponeurosis, with longitudinal separation of muscle fibre and peritoneum, as suggested by Stimson and extensively practiced in the gynæcological wards of the Jefferson Hospital, offers undoubted advantages in the performance of this operation in uncomplicated cases, especially in subjects with thick abdominal walls. A better view of the anterior pelvic structures is thus obtained and the manipulation of the ligaments facilitated, but its disadvantages in dealing with complicating new growths of large size or inflammatory processes with unyielding adhesions in the posterior pelvic segment are at once apparent to any one contemplating the limited range of exposure afforded by the opening.

Upon the completion of the operation the uterus occupies a well-poised median anterior position, and other conditions being equal, it simulates the normal in its re-

sponsive behavior to the influences of the respiratory act, to varying degrees of intra-abdominal pressure, as well as to the repletion and depletion of rectum and bladder. These changes obtain because the organ itself is in no sense directly fixed by sutures or artificial stays, but is supported by that portion of the round ligaments corresponding in structure with the musculature of the uterus, of which it may in truth be said, they are a continuation and form a part, and possess in no slight degree, therefore, the properties of elasticity and contractility, which, taken in connection with their cord-like form, and with the integrity and function of other uterine supports, are factors of first importance in securing the elastic and mobile equilibrium of the organ referred to, and in maintaining its normal prevailing tendency to a forward inclination in the presence of an ever-changing cycle of physiologic disturbances that tend to its displacement.

The segment of each ligament thus utilized is not alone the more muscular, but likewise the heavier and the stronger portion of its structure in every other respect, so that subsequent overstretching with a recurrence of the displacement is hardly to be feared and has not as yet been observed.

Compensatory evolution and involution of the ligaments during pregnancy and the puerperium are assured, while their extensive and firm union with the unyielding structures of the abdominal wall renders their detachment during the stress of parturition, or from any other cause, among the rarest of possibilities. In the absence of utero-abdominal attachments dystocia, as a result of the operation, can not occur.

The button-hole opening in each broad ligament is necessarily plugged and its edges inverted by the round ligament in its subperitoneal transit toward the abdominal wall, so that in cases uncomplicated by extra-uterine disease requiring additional surgical attention there are no raw surfaces, no preternatural openings through which knuckles of intestine may slip and become strangulated, nor

is there any other lesion left in the pelvis as a direct result of the operation for the formation of unfortunate adhesions and their retinue of possible evils.

The disposal of the slack in the broad ligaments by the necessary traction upon the round ligaments in pulling them through their newly-formed channels at once raises the prolapsed ovaries to a higher plane and a better circulation level.

If the displacement of the uterus is a partial expression of a general disturbance of the statics of the abdominal and pelvic viscera, the operation, if at all indicated, merely becomes one of several expedients to which recourse should be had for improving the patient's condition. In the presence of complicating diseased conditions requiring operative interference, the displacement may, or may not, prove a factor demanding special consideration. Curettement of the uterine cavity if indicated, and requisite plastic work on the cervix and vagina, should, as a matter of course, precede the abdominal operation.

The first operation as described in this paper was performed by Professor Montgomery at St. Joseph's Hospital, January 11, 1904, and he has repeated the procedure in 141 additional cases. I, myself, continued to practice ventro-suspension until convinced of the superiority of the new method, after having assisted in the operation many times and examined patients many months subsequently to determine the time value of the procedure. Within the past eleven months I have done the operation in 26 cases without an unfavorable incident and with the most gratifying results.

Three instances of pregnancy and labor following this procedure have come under the observation of as many competent practitioners of my acquaintance, all of whom reported that nothing unusual was noted in any of them, and that the subsequent behavior of the uterus was in nowise contrary to what was to be anticipated under normal conditions,—*i.e.*, perfect involution with the maintenance of a mobile forward inclination of the organ.

AN EXPERIMENTAL STUDY OF SUTURE OF ARTERIES WITH A DESCRIPTION OF A NEW SUTURE.¹

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THE methods of repair of arteries hitherto proposed are as follows:

I. MECHANICAL METHODS.—(a) Adhesive plaster methods, devised by Dr. G. E. Brewer. Advantage: The rapidity of application. Disadvantages: 1, A foreign substance is left in place; 2, secondary hæmorrhage occurs frequently; 3, obliteration of the vessel is common from too much pressure. (b) Abbe's method. The introduction of a glass tube in the lumen with suture of the artery. Advantage: Very slight chance of secondary hæmorrhage. Disadvantages: 1, The tube is a foreign body and by its presence causes irritation of the intima and produces thrombosis at the ends of the tube; 2, the tube may ulcerate its way out.

II. SUTURE METHODS.—(a) Invagination method devised by Dr. J. B. Murphy. Advantages: It gives a double thickness of the artery at the line of approximation. Disadvantages: 1, The artery is necessarily stretched; 2, the operative procedure difficult and long; 3, the lumen is narrowed; 4, the end of the artery allows fibrin ferment to enter the blood-stream; 5, fringes of intima hang in the blood current and assist in coagulation. (b) Suture of the outer two coats only. Advantages: None, over the through-and-through method. Disadvantages: 1, The blood can dissect its way between the

¹ Read before the Philadelphia Academy of Surgery, May 7, 1906.

coats of the artery and cause an aneurism; 2, fibrin ferment from the arterial walls has free access into the blood-stream; 3, fringes of intima hang in the blood-stream and assist in coagulation. (c) Through-and-through method. Advantage: Easy to perform. Disadvantages: 1, The suture is exposed to the blood-stream; 2, fringes of intima hang in the lumen. In the method now to be described attention is called to advantages: 1, The suture does not protrude in the lumen of the artery; 2, fibrin ferment cannot get from the ends or cut surfaces of the artery into the blood-stream; 3, the liability to secondary hæmorrhage is lessened by the double line of suture. Disadvantages: We have not observed any.

Description of the Suture.—Pagenstecher's thread Number One is used in the finest sewing-needle the thread will pass through. The clamps used are very limber-bladed forceps, devised by us especially for this work in order to avoid crushing the intima. The blades are covered with rubber tubing. (Figure 1.) Dissecting forceps are used to hold the edges of the artery. The suture can be used for a longitudinal, oblique or transverse (complete or incomplete) cut in the artery.

Method of Suturing a Longitudinal Cut.—(Fig. 2). The clamps are applied 2.5 cm. above and below the cut. The suture is started 1.5 mm. above the cut edge, the suture is passed through the outer two coats and tied, the end of the suture is grasped by a hæmostat, the needle is next passed through all the coats of the artery on both sides 1.5 mm. below the first suture and 1.5 mm. from the cut edge; the suture from now on is a continuous mattress with the dropping back one-half a suture length every third suture until the end of the incision is reached, then the suture is passed through the outer two coats 1.5 mm. below the lower end of the cut and a half-hitch made to tie the suture. The same suture is continued as a whip-stitch over the edges of the artery outside of the mattress suture until the starting-point is reached, when the two ends of the suture are tied. The artery is grasped in a gauze pad, the distal clamp removed, then the proximal clamp and the artery

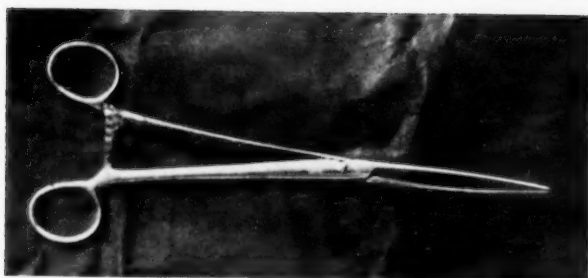


FIG. 1.—Special artery-clamp.

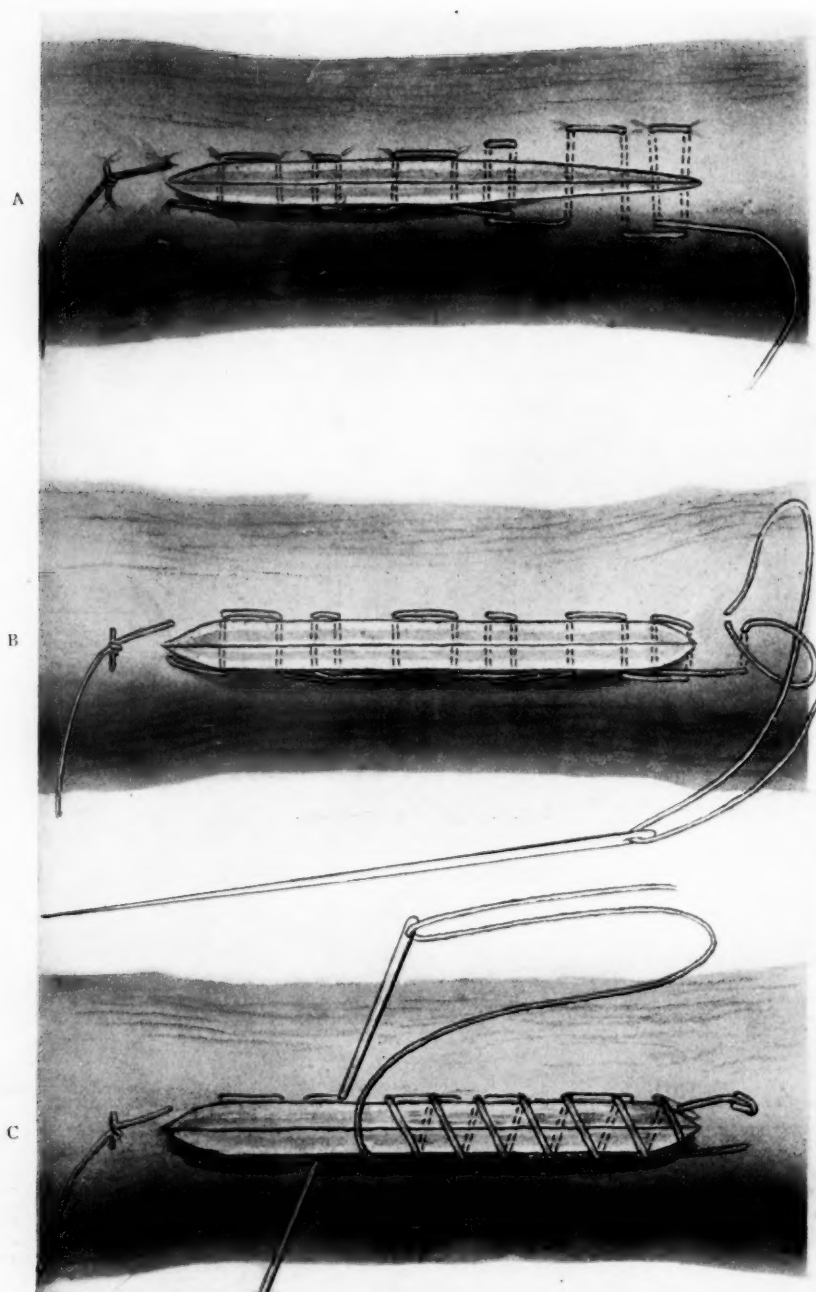


FIG. 2.—A, suture inserted and pulled tight in the lower half; B, suture inserted and pulled tight throughout; half-hitch made but not tightened; C, mattress suture pulled tight and half-hitch made, whipstitch partially inserted but not pulled tight.

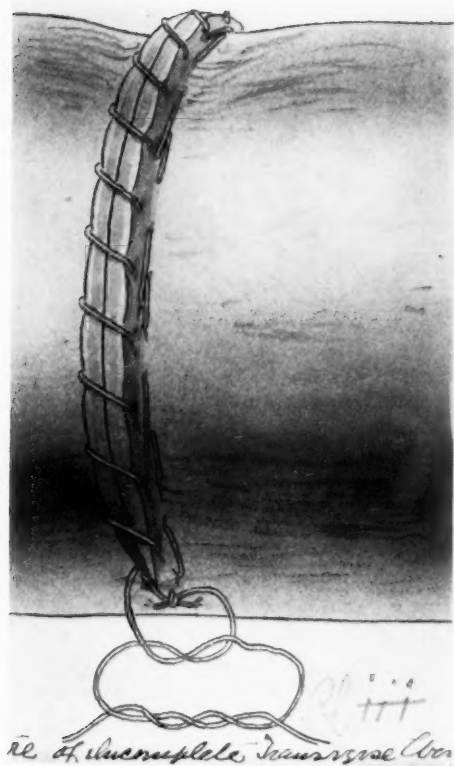


FIG. 3—Suture of incomplete transverse wound.

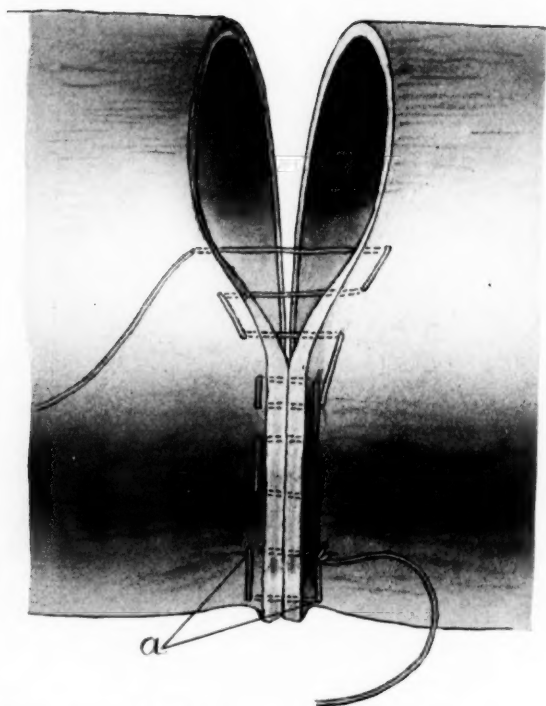


FIG. 4.—Suture of complete transverse wound ; A, mattress suture.

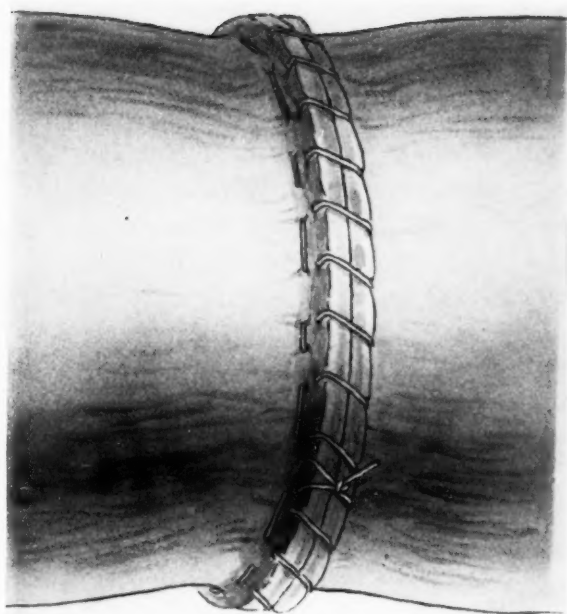


FIG. 5.—Suture of complete transverse wound, finished.

is dropped back in place and the deep fascia sutured around the line of approximation.

The method of suturing an oblique cut is practically the same as the longitudinal.

The Method of Suturing a Transverse Incision Half Way Through the Artery.—(Fig. 3.) The clamps are applied 2.5 cm. above and below the cut edges. The suture is started 1.5 mm. from the lateral end of the cut and passed through the outer two coats and tied; the end of the suture is grasped with a hæmostat. The suture is continued as a continuous-mattress suture, dropping back one-half a suture every third stitch until the opposite end of the cut is reached, then the suture is passed through the outer two coats and a half-stitch made to tie the suture; the same suture is continued back over the line of suture as an over-hand whip-stitch outside the mattress suture until the starting-point is reached, when the two ends are tied. The mattress suture should be 1.5 mm. from the cut edges at all times. The deep fascia should be sutured around the line of approximation.

The Method of Suturing a Complete Transverse Division of an Artery.—(Fig. 4, 5.) The clamps are applied as before. The cut edges of the artery are grasped with dissecting-forceps and the suture is passed through the upper edge of the artery from without in and through the lower end from within out; the needle is then reversed and brought back 1.5 mm. to one side of the former suture and tied. (This suture is really a single-mattress suture.) The suture is continued as a continuous-mattress suture, dropping back half a stitch every third suture until the starting-point is reached, then a half-stitch is made and the suture continued back as a whip-stitch until the starting-point is reached again; then the two ends are tied. The suture is started on the anterior surface near the handles of the clamps. When the suture reaches the farther side of the artery the handles of the clamps are taken from the lower portion of the wound and placed in the upper portion; in this way the surface of the artery which was anterior is now posterior, and the suture can always be kept in sight.

EXPERIMENTS.

CASE I.—Black horse, aged 20. Condition was very poor. The anæsthetic was chloral internally and chloroform by inhalation. An incision 20 cm. long was made on the left side of the neck, the carotid artery was found and the clamps were applied. A small vessel arising from the under surface of the artery was clamped and ligated. A longitudinal incision 4.5 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation, the artery could be seen pulsating. The wound was sutured with through-and-through sutures of silkworm-gut. The horse died from the effects of the anæsthetic three hours after the operation. Through a mistake of the attendant, the specimen was not recovered.

CASE II.—Black horse, aged 20. Condition was very poor; there were several sloughing wounds and sinuses over the body. The anæsthetic was chloral and chloroform. An incision 22.5 cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. The artery was divided transversely two-thirds the way through. The artery was sutured, the clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation, the artery could be seen pulsating. The superficial wound was closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the pulse was good and equal to that on the opposite side; the horse was unable to get up. Forty-six hours after the operation the pulse was equal on both sides; the horse was unable to get up and was killed by pithing. When the incision was opened up the wound was found to be infected; the artery was removed and examined; a very small lateral thrombus was present, but the lumen was not decreased. (Fig. 6.)

Pathological Report.—Gross specimen, preserved in a solution of formaldehyde, shows a portion of an artery dissected free from the periarterial tissues, the wall of practically normal thickness and without apparent gross trace of any marked hyperæmia. The vessel laid open shows the intima practically normal, save at site of the wound; the wound a partial transverse (slightly oblique) incision of the circumference, marked by a small clot extending in valvular fashion into the interior, and attached at the line of incision. This clot probably interfered but little, if any, with the flow of blood, and is apparently organized. The texture of the tissue of the wall shows no important gross changes.

Microscopic.—Section longitudinal, transverse to the line of operative wound. As seen in the section there extends from the line of closure of the incision a flap-like (valvular) thrombus into the lumen of the vessel, granular and fibrinous in structure, containing numerous scattered polynuclear leucocytes and a few eosinophilic cells. The wall of the artery is slightly thickened, its outer coat thickly infiltrated with poly-

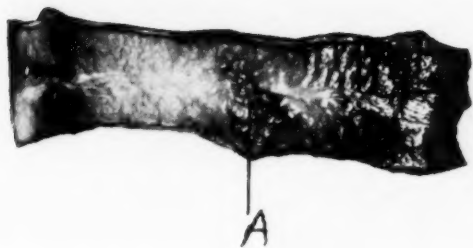


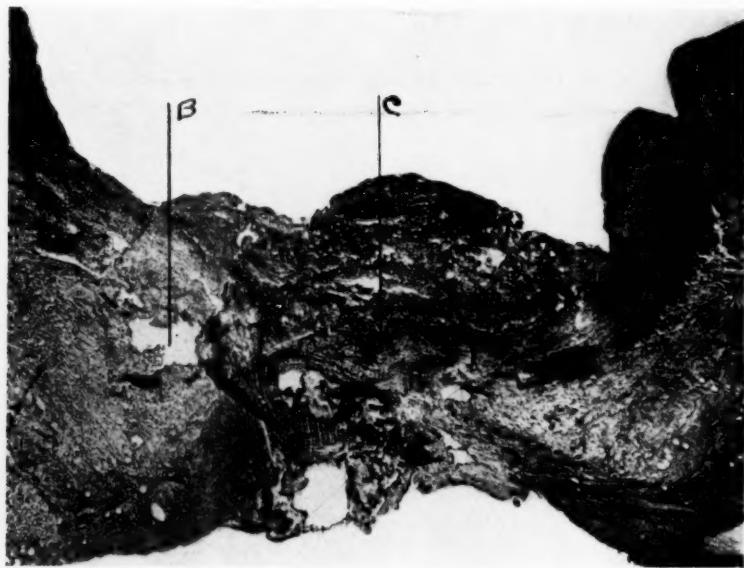
FIG. 6. CASE 2.—A, line of incision.



CASE 2.—B, remains of suture; C, small valvular thrombus.



FIG. 7. CASE 3.—A, line of incision.



CASE 3.—B, remains of suture; C, line of healing.

nuclear leucocytes, a smaller degree of the same type also existing in the other coats (prominent in part of the intima). The tissues in the line of enclosure (compressed by the sutures) are dense, more or less hyaline and staining without definition, and irregularly electing the hæmatoxylin and eosin tints. These tissues do not show any leucocytic infiltration. Especially in the outer coat the lymph-spaces are distended and contain a fibrinous coagulate, in which are seen scattered leucocytes. The endothelium of these spaces is swollen and occasionally desquamated. Throughout the wall but little cellular proliferation is evident.

CASE III.—Dog; Irish setter. Condition was good. The anæsthetic was morphine hypodermatically and ether by inhalation. The abdomen was opened and the abdominal aorta exposed 5 cm. above the common iliac artery; the clamps were applied and a longitudinal incision 2.5 cm. long was made in the artery. Bleeding occurred from the lumbar branches of the aorta, which were clamped and ligated. The artery was sutured with difficulty on account of the depth of the wound and the bleeding of the small veins. After the clamps were removed, the artery could be seen pulsating. Twenty-four hours after the operation the dog was in a weak condition, but the pulse was equal in both femoral arteries. Forty-eight hours after the operation the pulse could be felt in the femoral arteries, but was very rapid and weak; suppurative peritonitis was apparently present. Ninety-six hours after the operation the pulse could be felt in the femoral arteries; peritonitis was present, and as the dog was suffering acutely he was killed by chloroform. Post-mortem findings: Suppurative peritonitis was present; the artery was removed and opened up; a slight lateral thrombus caused by an infected suture was found. (Fig. 7.)

Pathological Report.—Gross specimen, a short length of abdominal aorta with its bifurcation, preserved in a solution of formaldehyde, shows the vascular wall with surrounding tissue closely adherent, and with discoloration from hyperæmia persisting. Laid open, the general intima shows no gross change. Over the line of longitudinal incision is a slight ridge of thrombosis apparently but little changed. The walls of the vessel, especially a little away from the line of closure (which is the thinnest part of the circumference), are thickened, hyperæmic and apparently the seat of inflammatory infiltration, but without gross appearance indicating suppuration.

Microscopic.—Section made transversely, at right angles with the line of operative wound. Over the incision in the lumen of the vessel lies a fibrinous thrombus, showing no organization as yet, with a rich polynuclear leucocytic infiltration along its base, and containing numerous hæmatoxylin-stained fragments (fragments of leucocytic nuclei). The line of incision shows a distinct mass of polynuclear leucocytes extending from the base of the clot to the exterior of the vessel. Tissue along the line of closure of the wound shows embedded suture, and it is densely hyaline in character, electing the eosin stain, being evidently necrotic. The general wall of the artery is deeply congested, at places infiltrated with blood; shows marked proliferation of the connective tissue, and

contains numerous polynuclear leucocytes, the latter densely infiltrating portions of the adventitia.

CASE IV.—Medium-sized dog. The anæsthetic was morphine and ether. The carotid artery was found on the right side of the neck, and the clamps were applied. A longitudinal incision 1.7 cm. long was made in the artery. The artery was sutured in the usual manner, the clamps were removed and no hæmorrhage occurred. The superficial fascia was sutured around the line of approximation, and the wound closed with through-and-through sutures. Twenty-four hours after the operation the dog was up and about, the pulsation was apparently normal. Three days after the operation the pulsation was normal, but the wound was infected. Four days after the operation the pulsation in the carotid artery was normal; the wound suppurating. The dog was killed on the fourth day; the artery was removed and opened up and a lateral thrombus was found.

Pathological Report.—The section of this specimen unfortunately takes in only one margin of the injury, which is apparently not closely approximated. The whole vessel wall is diffusely involved in acute inflammatory changes, with fusion of the similarly-involved surrounding tissue to the adventitia, so that no sharp demarcation of the outer coat of the vessel exists. Inside the vessel a comparatively fresh thrombus exists, adhering along the line of the wound. These tissues close to the line of injury are necrosed, taking diffusely and with poor definition the eosin stain; they are more or less diffusely infiltrated with blood, and the seat of numerous hæmic granules. Throughout the thickness of the vessel along this line the tissues are the seat of considerable leucocytic infiltration, of infection of the vasa vasorum, and of numerous round and spindle-shaped embryonic connective-tissue cells. Examples of phagocytic leucocytes are not infrequent.

CASE V.—Black horse, aged 20. Condition was very poor. An incision 22. cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. The artery was cut completely across and end-to-end anastomosis was performed. Some difficulty was encountered in holding the edges together on account of having only one assistant and the horse shaking with a fine tremor. The clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation. Twenty-four hours after the operation the horse was up and about, the pulse was good, full and equal on both sides. Three days after the operation the pulse was equal and the wound suppurating. Five days after the operation the pulse was good, full and equal on both sides; the wound was suppurating profusely. The horse was killed and the wound opened up; the artery was removed and incised; the lumen was not decreased, and no thrombus was present. (Fig 8.)

Pathological Report.—Gross specimen, preserved in a solution of formaldehyde, consists of a short segment of the artery freed from the surrounding tissues, with walls of apparently normal thickness and texture. Laid open, near the site of operation the intima is slightly

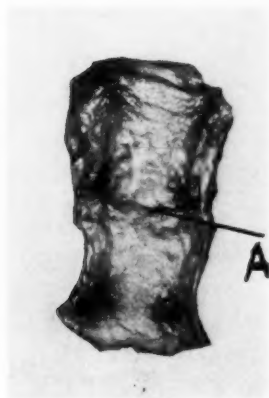


FIG. 8. CASE 5.—A, line of incision.

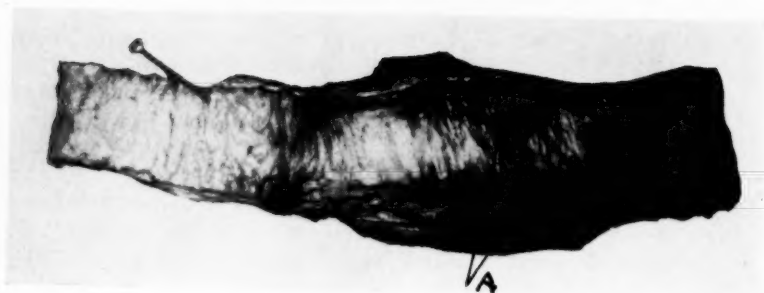
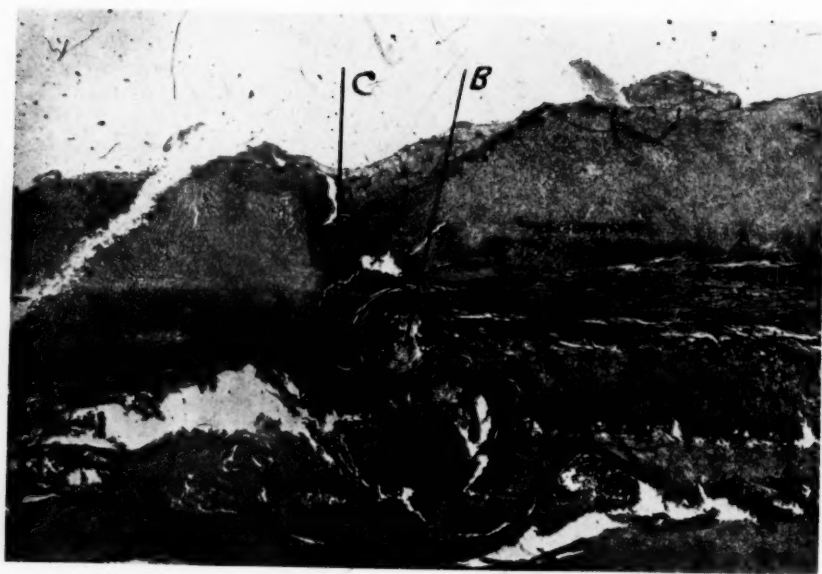


FIG. 9. CASE 6.—A, line of incision.



CASE 6.—B, remains of suture; C, line of healing.

nodular, apparently from slight focal swellings rather than from foci of thrombosis. The line of incision, a circular one, shows as a slight (circumferential) ridge a little less glistening than the adjacent intima, and presumably the seat of a small thrombus, which must, however, be partially organized. No distinct foci of softening from suppuration seen in gross inspection of the wall in section.

Microscopic.—Longitudinal section of artery (transverse to line of operative wound) shows a thin layer of granular clot over the site of wound; this clot is the seat of moderate leucocytic infiltration, especially toward the base (in clot numerous nuclear fragments probably from leucocytic disintegration). In one part of the clot evidence of beginning vascularization. On the outside of the vessel are several tiny foci of suppuration shown in the section, and in the inner muscular layer and intima is a similar infiltration somewhat more diffused. Little reparative activity evident, and the general wall remains thin, showing microscopically but little embryonic cell formation present in the layers. The tissue does not show a clear line of incision; an irregular fragmented part of the wall evidently represents the wound; and in this part there is a special tendency on the part of the tissues of the muscular coat to select the hæmatoxylin.

CASE VI.—Mouse-colored horse, aged 17. Condition was very poor. An incision 20. cm. long was made on the right side of the neck, the carotid artery was found and the clamps were applied. The artery was divided completely across and end-to-end anastomosis performed. The clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation. The pulse was equal in both submaxillary arteries. Twenty-four hours after the operation the horse was up and about, the pulse was good, full and equal on both sides. Three days after the operation the pulse was equal on both sides and the wound suppurating. Five days after the operation the pulse was equal on both sides. Seven days after the operation the pulse was good, full and equal on both sides, and the wound was still suppurating profusely. The horse was then killed and the wound opened up; the artery was removed and incised; the lumen was not decreased and no thrombosis present. (Fig. 9.)

Pathological Report.—The gross specimen, preserved in a solution of formaldehyde, shows an artery with the surrounding tissues at the site of operation intimately adherent to the external part of the wall, and with traces of discoloration and hyperæmia. Laid open, the intima shows a circular, slightly depressed line of operative union, without clear evidence of thrombosis, but somewhat roughened as if from a small deposit of this type. The gross section of the wall presents just beneath the line of closure, which is apparently firm, a small focus of pale opaque appearance, its substance somewhat softer than the general tissue, and suggesting a point of suppuration about a suture. The tissue of the deeper part of the wall and the adjoining tissue have a succulent appearance suggesting inflammatory infiltration rather than dense fibrosis from complete healing.

Microscopic.—Section made longitudinally, transversely to line of

operation. There exists a small definite fibrous clot upon the intima just over the line of incision. The incision has been obliterated by partial healing, but the whole wall of the vessel is much thickened by an intense exudative inflammation. The outer wall is the seat of wide distension of its spaces which are filled by a fibrinous reticulum thickly beset with polynuclear and eosinophilic leucocytes, and at several points suppuration evidently is focalizing. The muscle-layers in both coats are separated and sharply outlined by a cellular infiltration particularly rich in eosinophilic cells, and the intima is much thickened, particularly by an embryonal cell infiltration, full of capillaries. Embedded in the tissue at the site of the wound is a suture about which is a marked suppurative infiltration, and in its vicinity there is more or less necrosis of the older tissue indicated by its hyaline appearance and strong election of the eosin stain. The suppuration only in a minor degree is invading the deeper part of the thickened intima, and is apparently a process implanted after healing had partially proceeded.

CASE VII.—Bay horse, aged 14. The diagnosis of thrombosis of the iliac arteries was made by Dr. John W. Adams. The horse was transferred to us through the kindness of Dr. Adams. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. An oblique incision with ragged edges 2.5 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation, the artery could be seen pulsating. The superficial wound was closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the pulse was good and equal on both sides; the horse was up and about. Three days after the operation the pulse was equal on both sides and the wound was suppurating. Five days after the operation the pulse was equal on both sides. Seven days after the operation the pulse was equal on both sides and the horse was in good condition. Nine days after the operation the pulse was good, full and equal on both sides; the wound was suppurating. The horse was killed and an autopsy was performed by Dr. C. Y. White. The thrombosis of the iliac arteries was found as diagnosed before operation. The incision in the neck was wide open and the artery could be felt in the bottom of the wound. The artery was removed, opened up and a slight lateral thrombus found, but the lumen was not decreased. (Fig. 10.)

Pathological Report.—Gross specimen, preserved in a solution of formaldehyde, consists of an artery with the surrounding tissue closely adhering to its outer part, and with traces of previous hyperæmia persisting. Laid open, a line of incision extending longitudinally is marked out by a thin, somewhat elevated and irregular thrombus, in places apparently partly organized, but at others still red and relatively unchanged. The general lumen of the vessel could not have been importantly impaired thereby. The intima in this part of the vessel is generally roughened, with nodules and slight ridges, which are apparently for the most part points of slight thrombus formation, and in part due to local thickenings

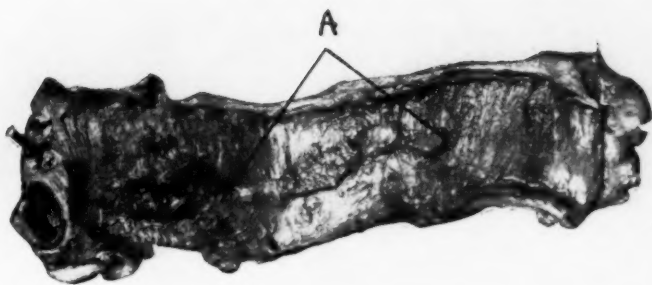
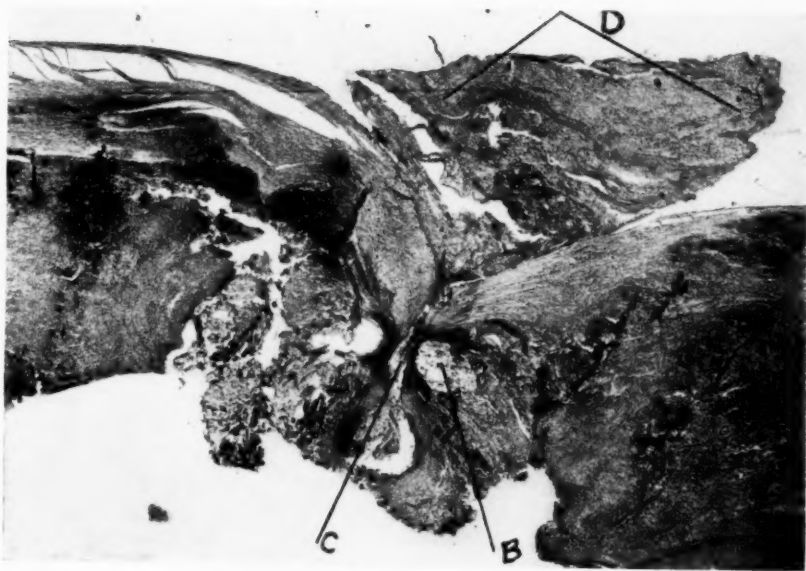
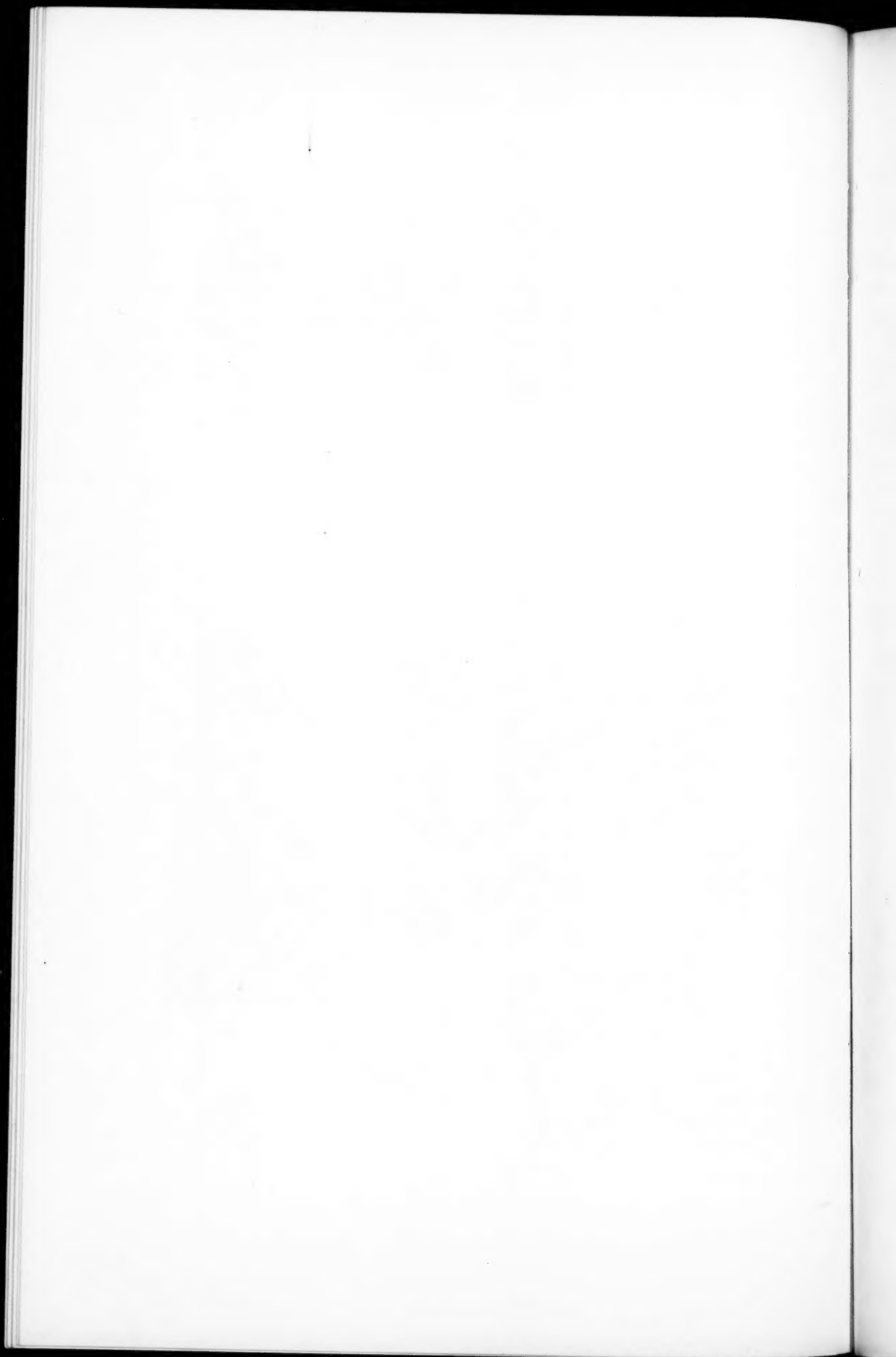


FIG. 10. CASE 7.—A, line of incision.



CASE 7.—B, remains of suture; C, line of healing; D, lateral thrombus.



of the intima. In cut section the thrombus is seen to be directly connected with the depression of linear closure of the arterial wound, and the intima generally seems redder than the deeper portions of the wall, the latter being, however, somewhat spongy and probably the seat of more or less inflammatory infiltration.

Microscopic.—Section made transversely to length of vessel, nearly transversely to the line of operative wound. Definite lateral thrombus overlying the line of wound shows no clear evidence of organization. Incision still to be traced through the whole thickness of the arterial wall; the tissues included within the sutures largely necrosed, hyaline, stained diffusely with the eosin of the hæmatoxylin and eosin preparation. From the borders of this hyaline part of the wall, marking the line of the wound adaptation, there extends diffusely through all the coats of the vessel a thick polynuclear leucocytic infiltration, in places (mainly media) rich in eosinophilic cells, with numerous endothelioid and embryonic connective-tissue cells interspersed. There is but little leucocytic infiltration in the clot, which, however, contains considerable hæmatoxylin-stained detritus, probably fragments of leucocytic nuclei.

CASE VIII.—Medium-sized dog. The anæsthetic was morphine hypodermatically and ether by inhalation. The carotid artery was found on the left side of the neck and the clamps were applied. An oblique incision 1.5 cm. long was made in the artery. The artery was sutured in the usual manner; the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation, and the wound closed with through-and-through sutures. Twenty-four hours after the operation the dog was up and about, and the artery was pulsating normally. Three days after the operation pulsation was apparently normal. His condition remained normal until he was killed, on the twelfth day. Post-mortem findings: The skin wound had united by first intention; the artery was removed and opened up; no thrombus was present, and the lumen was not decreased.

Pathological Report—Gross.—The artery is embedded in the surrounding tissues, which are closely adherent and are the seat of marked hyperæmia and inflammatory infiltration. Laid open, the vessel lumen is intact, the general intima smooth and glistening, and the line of incision marked by a small depressed linear scar.

Microscopically, there is marked hæmorrhagic infiltration in the surrounding tissues, together with numerous leucocytes and proliferated connective-tissue cells. No foci of suppuration. The whole wall of the vessel is the seat of numerous embryonic connective-tissue cells, mainly as fibroblasts. The line of incision is obliterated by a young scar. No appearance of thrombosis overlies this upon the intima, which is somewhat thickened and puckered at the site of the wound, but otherwise practically normal.

CASE IX.—Mongrel dog. The anæsthetic was morphine and ether. The carotid artery was found on the left side of the neck, and the clamps were applied. A longitudinal incision 1.5 cm. long was made in the artery. The artery was sutured in the usual manner; the clamps were

removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation, and the wound closed with through-and-through sutures. Twenty-four hours after the operation the dog was up and about, the pulse being apparently normal. Three days after the operation the pulsation was normal, but the wound was infected. The animal was normal until he was killed, on the fourteenth day. Post-mortem report: The artery was immediately removed and opened up; a small lateral thrombus was present.

Pathological Report.—The artery contains a thrombus composed mainly of red cells and a granular fibrin, with at one place numerous polynuclear leucocytes penetrating the mass. No evidence of actual organization of thrombus; and no appearance, in sections examined, of endothelial or subendothelial proliferation in reaction to thrombus; the only changes of this type are along the line of wound of the artery-wall. In the latter line of incision, which is quite approximated and closed, the wall of the artery from without to the endothelial lining is the seat of a mass of well-formed fibroblasts, uniting the approximated surfaces; and close to the cut and over it the endothelium shows as a single (at few places double) line of pyriform cells projecting into the lumen of the vessel, but apparently quite free from the clot within. At one point, close to the cut in the adventitia, and upon the opposite side of the artery in the surrounding fat tissue, are minute foci of suppuration. Remnants of the sutures persist. Apparently in this case the healing of the wound and the thrombus are not synchronous processes; the latter is too fresh to date back to the origin of healing. Perhaps it is a thrombus occurring secondarily in connection with the suppuration which is evidently beginning in the arterial coat. The healing itself seems, even to the formation of an endothelial lining, to be progressing favorably.

CASE X.—Bay horse, aged 18. His condition was very poor. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was found and the clamps were applied. One of the usual clamps was lost, and in its place a heavy hysterectomy forcep was used on the proximal end of the artery. The artery was divided completely across and circular end-to-end anastomosis performed. The clamps were removed and no hæmorrhage occurred. After the deep fascia was sutured around the line of approximation the artery could be seen pulsating. The wound was closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the horse was in good condition and the pulse equal on both sides. Three days after the operation the pulse was not as full or as strong on the operative side. The wound was suppurating. Four days after the operation the pulse was decidedly less on the operative side. Five days after the operation the pulse was very small on the operative side and the wound was still suppurating profusely. From the fifth to the fourteenth day the pulse gradually increased in volume and strength, but was not equal to the normal side at any time. The horse was killed on the fourteenth day by bleeding from the opposite side. The artery was removed and opened; a thrombus that almost filled

the artery was found, extending from the position of the heavy clamp down to the line of suture. Through a mistake of the attendant the horse was injected with formalin before the artery was removed. The thrombus was not of recent origin, so could not have been caused by the formalin.

Pathological Report.—The specimen examined grossly after preservation in a solution of formaldehyde shows an artery embedded in the surrounding tissues, and poorly defined from those about the level of operation. There is no evidence in the preserved specimen of any intense hyperæmia or hæmorrhagic infiltration of the tissues. Laid open, the vessel shows a dark, obstructing clot, which was slightly adherent along the line of operation, and which shows a more or less lamination on cross section. The line of incision is a circular one; it is somewhat puckered and overlaid by remnants of the clot, where the latter is torn off in the examination, and is superficially apparently firmly united. In section of the wall immediately beneath the slightly thickened intima at the site of closure are several points of softening apparently from suppuration and seemingly about the sutures. The general tissue at this site is soft and spongy, suggesting decided inflammatory infiltration.

Microscopic.—Section at site of operative lesion shows a thin, parietal granular (plaque) thrombus almost limited to the line of incision. The intima is thicker than normal near the lesion, but densely fibrous. Its endothelial coat is lost near the incision, and here its tissue stains with poor differentiation and strongly with the eosin of the hæmatoxylin-and-eosin preparation, giving the appearance of necrosis. Embedded beneath the intima is a loop of the suture used. This suture is surrounded by a dense infiltration of polynuclear leucocytes, and extending from this focus to the subendothelial portion of the intima on each side of the incision may be traced an infiltrating line of the same elements, along the border of the above necrosed part of the intima. The whole coat of the vessel is thickened, but definite suppuration is confined to the vicinity of the suture. The deeper coats are richly studded with round and spindle-shaped embryonic connective-tissue cells, with scattered leucocytes (numerous eosinophiles), and in the spaces of the adventitia the endothelium is swollen and often proliferated.

CASE XI.—Medium-sized dog. The anæsthetic was morphine hypodermatically and ether by inhalation. The carotid artery was found on the left side of the neck, and the clamps were applied. A longitudinal incision 1.5 cm. long was made in the artery. The artery was sutured in the usual manner; the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation and the wound closed with through-and-through sutures. Twenty-four hours after the operation the dog was up and about; the pulsation in the carotid artery was apparently normal. The animal remained normal until he was killed, on the twenty-first day after the operation. The artery was removed and opened up, no thrombus or narrowing of the lumen being present. (Fig. 11.)

Pathological Report.—Transverse section at site of injury shows complete healing of the intima, with perfect endothelial line. Intima at this

point thickened, the thickening impinging upon the deeper tissues rather than protruding into the vascular lumen. Inner elastic lamina perfect beneath the subendothelial thickening. The thickened intima is for the most part fully fibrous, but strands of embryonic cells (fibroblasts) pass

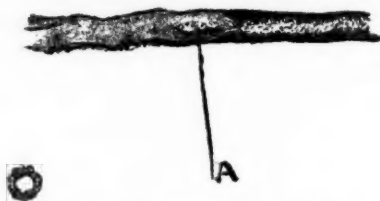
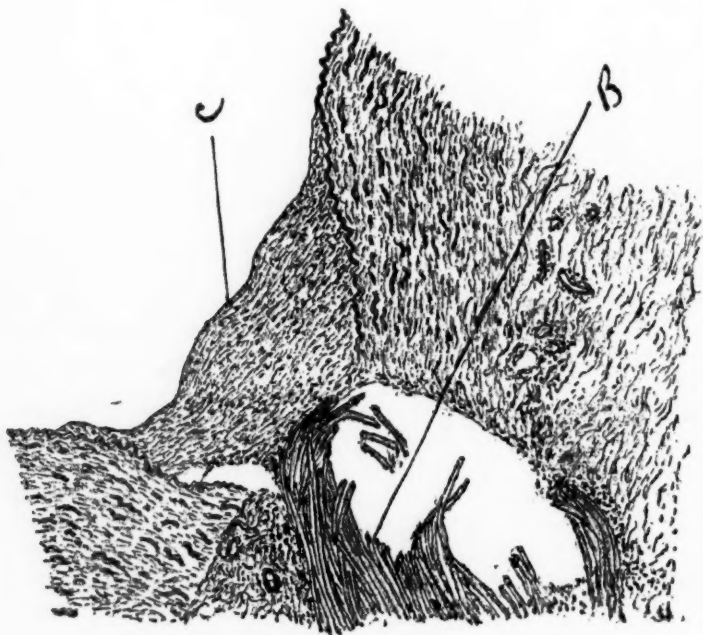


FIG. 11. CASE II.—A, line of incision.

into the mass along with capillary vessels. No evidence of thrombus on the intima. In the media there persist strands of the sutures with considerable young connective tissue intervening among the muscle-bundles.



CASE II.—B, remains of suture ; C, line of wound completely healed.

Here the elastic layers are somewhat broken in their continuity, but are quite apparent and show no appreciable degenerative changes. About the sutures among the young connective-tissue cells a few foreign-body giant-



FIG. 12. CASE 12.—A, line of incision.



CASE 12.—B, remains of suture ; C, line of healing.

cells are present. The adventitia presents practically the same features as just described in the media, and is slightly thickened from the fibrosis and young connective-tissue elements.

CASE XII.—Mouse-colored polo pony, aged 17. His condition was very poor. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was exposed and the clamps were applied. A longitudinal incision 3.5 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation, and the superficial wound closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the horse was up and about, the pulse was equal on both sides. Three days after the operation the pulse was equal on both sides and the wound was suppurating. The pulse was equal on both sides until he was killed, on the twenty-first day. Post-mortem findings: The artery could be felt at the bottom of the wound. The artery was removed and opened up; the lumen was slightly decreased, but no thrombus was present. (Fig. 12.)

Pathological Report.—The gross specimen, preserved in a solution of formaldehyde, consists of an artery closely welded with the surrounding tissue, traces of well-marked hyperæmia being present in the latter in the neighborhood of the operative wound. Laid open, the lumen is seen to have been permeable; the intima is marked by a slightly-elevated longitudinal line of about 3.5 cm. in length, thus presenting the appearance of recent scar-tissue rather than of an unorganized clot. Its irregular outline suggests, however, that it represents an organized linear thrombus rather than a direct adhesion of the applied surfaces of the intima. Transverse section inspected grossly corresponds with the above idea, the linear scar above mentioned being distinctly elevated above the surrounding surface of the intima, and below it in the wall are seen tiny foci of a softer, opaque substance suggesting points of suppuration; the deeper parts of the vessel-wall and the immediately-surrounding structures have a somewhat spongy or succulent appearance, suggesting marked inflammatory infiltration.

Microscopic.—Transverse section of artery, at right angles to the line of operative incision, shows over the site of operative line a small partly-organized thrombus. The organization is more perfect along the lateral borders of the clot. At its base, close to the line of the incision, there begins a polynuclear infiltration which continues outward through the intima to become especially marked about an embedded suture. The tissue between two strands of this suture (evidently section of the loop) is necrotic, almost hyaline, and poorly staining. All the coats are thickened and studded with embryonic elements, scattered leucocytes (many eosinophiles especially near the line of suppuration), and endothelioid cells (proliferated endothelium of lymph spaces). In several foci presumably near a suture giant cells are found in greater or smaller numbers. The general appearance here suggests that the clot was of earlier occurrence than the suppuration, and that the latter process is penetrating into the partly-healed wound.

CASE XIII.—White horse, aged 20. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made on the right side of the neck; the carotid artery was exposed and the clamps were applied. A longitudinal incision 3.7 cm. long was made in the artery. The artery was sutured, the clamps were removed and no hæmorrhage occurred. The deep fascia was sutured around the line of approximation and the superficial wound closed with through-and-through sutures. The pulse was equal on both sides. Twenty-four hours after the operation the horse was up and in good condition, the pulse being equal on both sides. Three days after the operation the pulse was equal on both sides; the wound was suppurating. The pulse was equal on both sides until the horse died, from a small secondary hæmorrhage, on the thirty-third day. The artery was removed from the wound and examined. It opened into a pus sac which completely surrounded the artery; the lumen was not decreased, and no thrombus was present. It did not seem possible the horse could have died from the small secondary hæmorrhage, but no other cause could be found. (Fig. 13.)

Pathological Report.—The artery contains a thrombus composed mainly of red cells and a granular fibrin, with at one place numerous polynuclear leucocytes penetrating the mass. No evidence of actual organization of thrombus; and no appearance in sections examined of endothelial or subendothelial proliferation in reaction to the thrombus; the only changes of this type are along the line of wound of the arterial wall. In the latter line of incision, which is quite approximated and closed, the wall of the artery from without to the endothelial lining is the seat of a mass of well-formed fibroblasts uniting the approximated surfaces, and close to the cut and over it the endothelium shows as a single line of pyriform cells projecting into the lumen of the vessel, but apparently quite free from the clot within. At one point, close to the cut in the adventitia and upon the opposite side of the artery in the surrounding fat-tissue, are minute foci of suppuration. Remnants of the sutures persist. Apparently in this case the thrombus is too fresh to date back to the origin of healing. Perhaps it is a thrombus occurring secondarily in connection with the suppuration which is evidently beginning in the arterial coat. The healing itself seems, even to the formation of an endothelial lining, to be progressing favorably.

CASE XIV.—Sorrel horse, aged 18. The anæsthetic was chloral and chloroform. An incision 22. cm. long was made in the right side of the neck; the carotid artery was exposed and the clamps were applied. The artery was divided transversely two-thirds the way through and then sutured, the clamps were removed and no hæmorrhage occurred. Some difficulty was encountered in suturing because of a very fine tremor. The deep fascia was sutured around the line of approximation, and the superficial wound closed with through-and-through sutures. The pulse was equal on both sides and the horse was in good condition. Twenty-four hours after the operation the pulse was equal on both sides. Three days after the operation the pulse was equal on both sides and the wound was infected. The pulse were equal until the tenth day, when the pulse on the

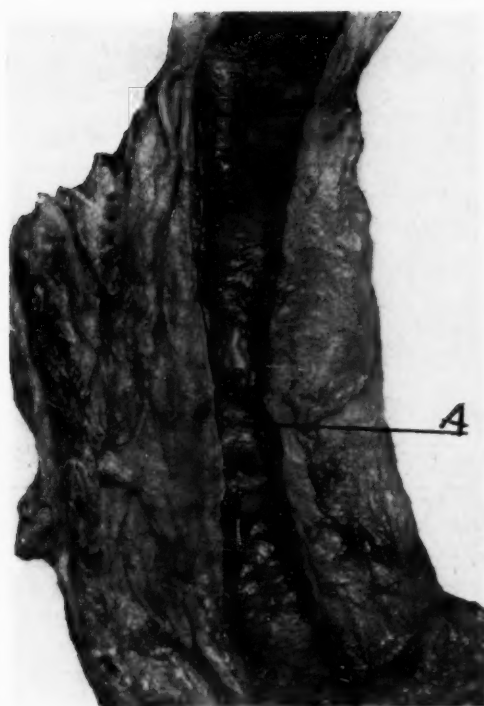


FIG. 13. CASE 13.—A, line of incision.



CASE 13.—B, lateral thrombus; C, pus.

operative side was slightly less. The wound was suppurating profusely. From the tenth until the eighteenth day the pulse was decidedly less on the operative side. From the eighteenth day until the forty-second day the pulse gradually increased in volume, but was not equal to the opposite artery at any time. The horse was killed on the forty-second day. The wound was suppurating profusely. The artery was removed and opened up. Complete thrombosis was found. In dissecting out the artery the vein was found very much thickened.

Pathological Report. Gross Specimen.—Two lengths of the vessel, preserved in a solution of formaldehyde, are presented for examination; both are the seat of occluding thrombosis; the thrombi are dark in the central part and paler and more or less organized and adherent to the intima along the periphery. The general wall of the artery is thickened, pale and dense from sclerosis. No appearance of suppurative softening on gross inspection.

Microscopic.—A section made transversely to the length of the vessel contains a large thrombus with organization proceeding, the greater part of the clot being well cellularized. Phagocytic leucocytes are numerous in the interior of the clot. No evidence of suppuration present. Distinct extension of fibroblasts and young vessels from the intima. The general coat of the vessel shows no evidence of suppuration; the blood-vessels are slightly injected, their coats are unusually thick; but little embryonic cell-formation is evident; when seen it mainly exists about the vasa vasorum, in the adventitia, and between the muscle-bundles of the media.

There were fourteen operations in all—nine on horses and five on dogs. The experiments on the nine horses and one dog were performed at the Veterinary Hospital of the University of Pennsylvania. The operations on the remaining four dogs were performed in the surgical operating-room of the medical laboratory. All the cases operated on at the Veterinary Hospital suppurated, and half of those at the laboratory. The operations on the horses were three complete circular, two transverse, three longitudinal and one oblique; on the dogs, four longitudinal and one oblique. When the arteries were opened up, in seven no thrombus was visible, in five a slight lateral thrombus was present; in one case we used a heavy hysterectomy forcep instead of our special clamp (clamp lost in transporting instruments), and almost complete thrombosis was present from the position of the clamp to the line of suture; in another case complete thrombosis occurred from infection around the artery. One ruptured on the thirty-third

day into a pus-sac surrounding the artery, but no thrombus was present.

Conclusions.—1. Only one secondary hæmorrhage occurred, and that one was directly traceable by microscopical examination to infection from without; this alone is a distinct advantage over the older methods. 2, Under the aseptic conditions employed in human surgery the results ought to be perfect, as our thrombosis can almost always be traced to infection. 3, Whatever suture used, the principle of placing the intima to intima is absolutely essential. 4. The suture must be kept out of the blood-stream.

In closing I wish to acknowledge my indebtedness to Dr. De Forest Willard for his many valuable suggestions and for the financial aid which made it possible to perform these experiments, and to Dr Allen J. Smith for the pathological reports. I also wish to thank the staff of the Veterinary Hospital for their many courtesies and Dr. Barnett, Resident Physician, in particular, for valuable assistance in many ways and for untiring efforts in my behalf; Mr. H. S. Hutchinson and Mr. F. Beekman, of the third-year medical class, for their assistance.

**COMBINED SUPERIOR TIBIOFIBULAR AND AS-
TRAGALOFIBULAR OSTEOPLASTY AS A
MEANS TO PREVENT SHORTENING OF THE
LEG AFTER EXTENSIVE OSTEOMYELITIS OF
THE TIBIA OCCURRING DURING ADOLES-
CENCE.¹**

BY NORMAN KERR, M.D., C.M.,

OF CHICAGO.

ACUTE inflammatory lesions of bone under the term of Necrosis, have commanded the most serious attention of the medical profession since the earliest history of medicine, and it was Chassaignac in 1854 who first applied the term "osteomyelitis" to that suppurative affection of bones, which is of so-called idiopathic origin.

It may be interesting to us as Americans to note that this disease was minutely described by Nathan Smith in 1829. The case was that of a colored boy eleven years of age, who was admitted to the Baltimore Infirmary for the treatment of disease of the thigh. To any one who may be interested, a full description of this case is given on page 121 in his "Medical and Surgical Memoirs."

Early diagnosis followed by prompt and thorough evacuation of the infected area by a sufficiently long incision of the soft parts, including the periosteum, combined with free opening of the medullary canal is regarded by the profession the proper procedure to carry out, but it is in the later stages that considerable difference of opinion exists in the minds of progressive surgeons.

Some advise the expectant plan after free drainage is established because they fear that the periosteum may not be able to generate new bone; others depend on this membrane with an abiding faith, and it is quite remarkable to note that those

¹ Read before the Chicago Surgical Society, April 6, 1906.

belonging to the former class assign no reason why it does not do so.

Nichols, with what might be called a wise diplomacy, supported by an extensive knowledge gained from his experimental work, takes a somewhat middle course and advises waiting until the periosteum demonstrates its ability to reproduce new bone by the appearance of osteoblasts on this membrane; then he advises the radical removal of the shaft and epiphysis if necessary, and thorough antiseptic cleansing of the infected parts, after which the periosteum is sutured and the cavity obliterated. His work constitutes a considerable advance in the treatment of this very serious disease, and the time that is usually the most favorable in his opinion for the removal of the shaft is from the eighth to the tenth week after the onset of the disease.

The results obtained by Cushing and others in Boston certainly seem to warrant the assumption that the above procedure is a marked improvement over the older methods of delay.

Reverting to the early treatment, Nichols advises that the endosteum be not disturbed as is so often done by the curetting of the bone-marrow. His conclusions are:

a. Drainage of the soft parts is not sufficient; the bone-marrow is often infected and must be drained.

b. A portion of the cortical bone must be removed by the trephine.

c. Curetting of the bone-marrow should not be done, as it causes extensive destruction of the endosteum.

d. Operate as early as possible.

e. In the subacute stages, remove the necrotic shaft completely or partially at an early stage; for mechanical reasons the manipulation of the periosteum is easier after ossification of the periosteum has begun, but while the membrane is still plastic, and the rapidity and surety of perfect regeneration seem greater at that time.

f. Early performance of an operation and removal as far as possible of all infected areas lead to an earlier success.

Berndt is one of those who never has any fear that the

periosteum will not generate new bone, while Küster claims that failure sometimes occurs.

The question of the ability of the periosteum to generate new bone is very important, because in many cases this takes place so rapidly that great shortening of the limb is prevented, particularly in those patients who are nearing the end of the period of adolescence, also in those in whom the epiphyseal line is not destroyed by the disease.

Von Bergman clearly draws attention to the fact that if the disease, in cases in which the tibia is involved, is only of sufficient activity to stimulate the epiphyseal line, lengthening of the bone takes place and a position of valgus occurs; but if the line is destroyed, in whole or only partially, shortening results in a position of inversion of the foot.

There are cases on record, particularly of severe traumatism to the tibia, in which the shortening was so great that the patient had to bear the weight of the body on the outer malleolus in some cases, and in others had to contend with the disability incident to the upward displacement of the fibula on account of this bone occupying a position external to the knee-joint.

A review of the literature on the subject of osteomyelitis, while it brings out many interesting and practical points, fails to inform us what percentage of cases have their origin in the upper and lower ends of the tibia respectively; but it is probable, inasmuch as the lower end of the femur is the area most frequently involved of all the bones, that the upper end of the tibia is attacked oftener than the lower, because the growth in the upper portion is estimated to be about three-fourths of the whole, while the lower is one-fourth.

The experience gained from the following case seems to the writer to warrant the conclusions: That the periosteum can be relied upon to regenerate new bone; that it is not necessary to wait for two or two-and-a-half months for evidences of repair on the part of this membrane, and that it is even better to remove the shaft of the tibia entirely just as soon as one feels satisfied that the vitality of the involved bone is sacrificed;

that on account of the difficulties of rendering the parts sufficiently aseptic, through-and-through drainage either with gauze or tubes should be instituted just preliminary to the suturing of the edges of the periosteum together.

The principal point in this case and the one which the writer believes to be of value in properly selected cases, is the substitution of the fibula for the tibia as the pressure-bearing bone, in order that continued growth in the length of the leg may be maintained.

The time since the operation is entirely too short to prove absolutely whether the fibula will continue to grow in length as fast as its fellow, but the writer believes it will. Another advantage of this line of treatment, properly carried out, is the great saving of time, because as soon as suppuration has ceased the double osteoplasty, described later, can be performed and the patient allowed to walk as soon as he can after being treated for a compound fracture, say six or eight weeks.

The procedure suggested is as follows,—which, however, was not carried out in this case, because only one osteoplasty was done at a sitting, whereas both should have been performed on the same day and much time saved:

First. Remove all the infected bone and suture the edges of the periosteum together, except at the ends, and drain sufficiently; at the same time prevent deformity as much as possible by the use of splint or cast.

Second. After suppuration has ceased, destroy the upper tibiofibular joint and cause ankylosis at this point; also divide the lower end of the fibula on a level with the upper surface of the lower epiphysis if this is not destroyed, or the astragalus if the epiphysis of the tibia has been sacrificed to the disease, and place the end of the fibula on the new location, either the lower epiphysis of the tibia or the astragalus.

The case report is as follows:

Francis D., aged 10. Had scarlet fever and diphtheria several years ago. Father living and in good health. Mother died of tuberculosis two years ago. Present illness: September

26, 1905, he fell and hurt his left leg near the ankle; three days afterward he went to bed, and a physician was called on October 2d, who, about a week later, made several short incisions and evacuated a large amount of pus. On October 21st he was admitted to the Children's Memorial Hospital suffering from great pain in the leg, which was flexed to a right angle with the thigh, and entirely functionless. Denuded bone could be detected to a great extent with a probe. Hot moist antiseptic dressings were ordered, to be changed every eight hours, and on October 24th a free incision was made over the tibia and the shaft found bathed in pus with the periosteum attached in a thin line on the posterior surface only. The entire diaphysis, lower epiphysis, and the upper portion of the astragalus, were removed down as far as the lateral articular surfaces extended.

After thorough irrigation, the space occupied by the removed bone was filled with iodoform gauze and the periosteum sutured over it, the gauze projecting at the upper and lower extremity of the incision.

A plaster-of-paris cast was applied from the upper part of the thigh to and including the foot. In two days the anterior portion of the cast was cut away, but enough was left about the foot, it was thought, to prevent deformity.

The gauze was removed and tubular drainage substituted, after which moist dressings were kept up until November 30th, then dry dressings until December 12th, when the condition of the leg seemed to warrant the safety of further operation without the danger of reinfection.

The foot by this time was markedly inverted and the following procedure carried out: An inverted U-shaped incision was made, commencing in front of the lower end of the fibula, passing up in front of this bone about four inches, then across and down almost to the level of the starting point, but behind the fibula. The flap thus outlined was turned down of all the soft parts over the bone, including a strip of periosteum about one-third of an inch, with the hope that it would form a sort of brace, and add strength to the leg subsequently. An examination of the last skiagraph taken shows that this hope has been partly realized.

The fibula was now divided with a chisel, on a level with the upper surface of the remaining portion of the astragalus,

and displaced inward until the foot assumed a marked everted position and the end of the fibula rested on the astragalus.

Before this operation the measurement from the lower edge of the right patella to the tip of the external malleolus was 32 cm., whereas the corresponding measurement on the left leg was 30 cm. The patient was allowed to walk about the middle of January, 1906.

On February 1st the measurement from a board touching both heels to right anterior superior spine of the ilium was $29\frac{1}{2}$ inches, or 75 cm., while the left was $28\frac{3}{4}$ inches, or 73 cm., and the distance from the top of the left fibula to the top of the tibia was one cm. less than that on the right leg, thus showing already a slight displacement upward of the fibula.

There was also considerable more motion about this joint than the right, consequently it was considered necessary to destroy it and produce fixation at this point in order to prevent further displacement upward.

On February 2d the boy was again anæsthetized and an incision anterior to the joint made; the articular surfaces were chiseled away; a depression was chiseled into the tibia about two cm. anterior to the normal location of the head of the fibula and the head forced into it, where it was held in place by a heavy kangaroo-tendon suture, carried through the head of the tibia and around that of the fibula.

The skiagraphs show the irregularity of the new tibia and its medullary canal, also the formation of a support from the tip of the fibula to the shaft, which has been thrown out by the periosteum, detached for that purpose.

THE RELATION OF THE TECHNIQUE OF NURSES AND OF HOSPITAL APPARATUS TO THE HEAL- ING OF WOUNDS.

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IT is the general belief of surgeons that infection in wounds, almost without exception, occurs in the operating-room as a result of introducing pathogenic microorganisms into wounds upon the hands of the surgeon or his assistants, or by means of the instruments or suture material or dressings employed. This belief has become general since the older theory that germs usually come in contact with wounds by means of the air was disproved. This source of contagion is believed to be a possibility, but practically to play a very small role in infection. This belief was held by myself and served as the practical basis of my own work until from experience I became convinced that the theory was not sufficiently broad to cover all the facts in hospital practice.

Some time ago, having occasion to investigate a series of infections occurring in clean wounds, I was driven to the conclusion that the infections did not occur in the operating-room, and upon careful investigation was satisfied that they were due to errors in technique on the part of the nurses, either before or after the patients had been operated upon. This experience led me to study the question of the technique of nurses and of the apparatus supplied to nurses in hospitals with which to perform their duties. It also led me to consider the wisdom of the plan usually followed by surgeons, including myself, of giving verbal orders to the head nurse in charge, and depending upon her to maintain a proper technique on the part of the pupil nurses.

¹ Read before the Philadelphia Academy of Surgery, May 7, 1906.

In this particular investigation I learned that the technique in use was quite different from what I believed it to be. Verbal orders had been given for many years, modified by other verbal orders from time to time, so that it was not surprising that the result of such a method should be a lack of exactitude in detail in carrying out general principles.

As a result of this experience I determined to adopt a technique which should be printed, so that there could be no question upon the part of the head nurse as to what was required, and no possibility on the part of any pupil nurse of misunderstanding the instruction of the head nurse.

With the assistance of the hospital staff a technique was compiled which was submitted to various head nurses for suggestions, and was used for a year so that it might be corrected by practical experience before being printed and finally adopted.

The result of this experiment, which I believe is novel, has been most satisfactory to all concerned. The long-continued series of infections which led to the investigation was promptly cut short and for nearly a year primary union was obtained, without exception, in non-suppurative cases.

During this particular series of infections already referred to, the same operating-room technique was employed which had been in use for a long time, with the result of obtaining primary union without suppuration in 98 per cent. of cases. When the infections began to occur, it was naturally supposed that this was due to carelessness on the part of some one connected with the operating-room. The personnel was gone over, every one was stimulated to rigid care in every detail of asepsis, with no improvement in the results secured. The sterilizing apparatus connected with the operating-room was overhauled and put in perfect order, and the time devoted to the sterilization of instruments, dressings, etc., and the disinfection of the hands was doubled, without result. Also the preparation of the field of operation was made more rigidly. These facts led me to consider whether it was possible for the wounds to become infected elsewhere. A peculiarity of the series of infections was that as a rule they were mild. The

mortality during the series, which extended over a number of months, was not increased. There were no cases of peritonitis in a long series of abdominal sections, and the infections as a rule occurred late and were confined chiefly to the subcutaneous fat. Finally, not only celiotomy wounds, but those of Alexander operations, hernias and eventually plastic operations upon the uterovaginal canal likewise became infected.*

Upon investigating the technique in use in the wards of the hospital I found evidence that the hands of the nurses were not adequately disinfected, that the douche bags were not sterilized, sterilization being limited to the douche-nozzle; that the basins and trays employed were not systematically sterilized (dependence being placed upon the solutions they contained for their sterilization), and that the methods in use for sterilization were far from satisfactory; also that the bath-tubs, while clean in the domestic sense, were not disinfected. It seemed to me to be a rational conclusion that patients being admitted to the hospital and given two or three baths in a bath-tub presumably septic, before being operated upon, and being prepared for operation by the hands of nurses which were not sufficiently disinfected, enough pathogenic microorganisms became implanted upon the skin of the patients to explain the series of infections. In order that this theory should be tenable it was, of course, necessary that the bath-tubs and the apparatus used by the nurses should have been infected from some patient early in the series of infections. In order to test the matter, rigid regulations as to the sterilization of all the apparatus used by the nurses, the disinfection of the bath-tubs and of the nurses' hands, were at once instituted and the usual technique of sterilization formerly in use in the operating-room was reverted to; that is, the amount of sterilization in the operating-room was cut down one-half. The result was

*During the time that the infections were occurring in the hospital, the same assistants, dressings and suture material were used repeatedly in operations elsewhere without infection occurring in wounds. It was this fact which finally induced me to look elsewhere than in the operating-room for the source of the difficulty.

immediate. The infections disappeared and the series was at an end.

It seems to me that the demonstration was complete that this series of infections came about in the way suggested. It has long been known that it is impossible to sterilize a surgeon's hands infected with virulent microorganisms by any means at our command, without a period of two or three days having elapsed since the infection took place. As a concrete example of this fact, in the early days, probably every abdominal surgeon had the experience of performing a celiotomy within one or two days after having examined a woman suffering from puerperal septicæmia, or having operated upon an abscess containing streptococci and of having the unhappy experience of seeing his patient contract a virulent septic peritonitis, with a fatal termination. The conditions were entirely similar in principle. The skin of the patient was infected with pyogenic microorganisms from the bath-tub or the nurse's hands, and the subsequent efforts at disinfecting the field of operation within the next day or two days were insufficient to render the field entirely sterile. The number of germs introduced in any case was insufficient to cause a fatal peritonitis, but did bring about suppuration in the wounds.

It seems to me that this demonstration is of sufficient importance to bring it to the attention of surgeons who, in general, like myself, have been convinced that to prevent suppuration in wounds it is only necessary to maintain a rigid technique in the operating-room.

Being convinced of the facts in the case, I investigated the nature of the apparatus in use by the nurses and the facilities afforded them to sterilize the same efficiently, and also the facilities afforded them for disinfecting their hands, when it became evident that these facilities were by no means adequate to obtain the best results. I therefore determined to institute a radical change. The problem was to eliminate all apparatus which could not be sterilized by boiling, to provide proper sterilizers by means of which all apparatus could be sterilized, and to study the problem of how the hands of the nurses could

be kept from contact with infected objects, and, in addition to this, to prescribe rigid regulations for the disinfection of the hands of the nurses. It required but little study to determine that, as hospitals are usually conducted, the hands of the nurses are constantly coming in contact with infected objects; for example, bed-pans are constantly receiving infected dejecta from the bowels, douche-pans are constantly receiving infected discharges from the genitalia, pus-basins and vomit-trays likewise are constantly handled by nurses, and the provision for the systematic sterilization of these utensils is lamentably poor or entirely absent. It was at once clear that if the hands of the nurses are to be kept free from contact with septic objects all such apparatus must be systematically sterilized.

It was clear also that under the usual conditions obtaining in hospitals all the objects about the wards with which the hands of the nurses come in contact might prove sources of infection, and that all such objects must be systematically disinfected.

A sterilizing plant was installed in the bath-room upon each floor sufficiently large to contain a dozen bed-pans or douche-pans. By means of high-pressure steam these can readily be sterilized by boiling. A rule was adopted that all bed-pans and douche-pans should be sterilized once daily, and thereafter stored in a clean closet until used. After use they are washed out in the usual way and drained. This prevents the carrying over of infection from one day to another. It would, of course, be more ideal if they were sterilized each time after use, but this was deemed to be an unnecessary nicety in practice. The point was to prevent carrying over infection from time to time or from one case to another. In addition to this, the customary rule that the apparatus in use upon septic patients should be isolated, was, of course, continued. A sterilizer similar to that used in operating-rooms for the sterilization of instruments was installed in each diet-kitchen, so that all of the basins and trays, catheters and instruments used by nurses can be sterilized as efficiently as is done in the operating room.

A rule was adopted that all basins, pitchers and trays used by nurses shall be cleaned and boiled for ten minutes after use, and then stored in formaldehyde solution 1-4000; also that this solution shall be changed daily. All bowls for solutions must be again boiled before using. A general rule was adopted that all apparatus used by nurses must be sterilized at least once daily.

A definite technique for the disinfection of the nurses' hands was adopted, as follows: The hands shall be scrubbed for three minutes with soap and water and a sterile nail-brush. The finger-nails shall then be cleaned with a sterile wooden nail-cleaner, and the hands shall be scrubbed again for three more minutes. The hands shall then be soaked in formaldehyde solution 1-500 or bichloride of mercury solution 1-1000, for two minutes.

As a further precaution against the possibility of infecting the skin of patients admitted to the hospital, in addition to preparing for the disinfection of the bath-tubs and the nurses' hands, a plan was adopted of having all patients prepared for operation during a certain period by a nurse assigned for that duty, called the preparing nurse, whose hands are thus kept from contact with septic material.

In applying the general principle of keeping the hands of the nurses free from septic material there were numerous details to be worked out, some of which have been met as follows: It is required that, after the usual daily cleaning by the ward maid, the door-knobs, window-sills, tables, chairs, bureaus, bedsteads, poles for douche-bags, and the tops of all furniture or objects in the wards or rooms, shall be wiped off with formaldehyde solution 1-500 by the nurse; also, that all shelving in the diet-kitchens and in the rooms in which the apparatus for nurses is kept, shall be washed daily; on alternate days with soap and water, and with formaldehyde solution 1-500.

Among other objects with which the hands of the nurses come in daily contact there are probably none which are more septic, if not absolutely dirty, as hospitals are usually con-

ducted, than the rubber sheets which are used to protect mattresses. The usual method of caring for these is to wipe them off when the patient is discharged and then to put them on another bed; and it is quite probable that even this wiping off process is often omitted. As these sheets necessarily receive discharges from the bowels, from the vagina, and from discharging wounds in many cases, from the necessities of the situation they must always be covered with pathogenic micro-organisms and are, therefore, a fruitful source of infection of the hands of nurses.

Such rubber sheets are treated by washing them thoroughly after use, after which they are soaked in formaldehyde solution 1-500 for twelve hours, wiped dry and put away in a sterile cloth, rolled on a roller, until used again.

The vomit-trays and pus-basins were eliminated as sources of infection of the nurses' hands by classing them with the other basins and trays in use, and having them cleaned and sterilized and stored in formaldehyde solution each time after use.

Another source of infection of the nurses' hands are the cans which are used to receive the dressings and waste from the wards. Such cans are in constant use in all hospitals, and receiving, as they do, septic dressings, they are a prolific source of infection of the nurses' hands. This source of infection was eliminated by requiring that the lids of the cans should be permanently removed, so that it is unnecessary for the nurse to touch the cans. When the cans are taken to the engine-room in order that their contents may be burned, they are cleaned, and then boiled in an apparatus installed for the purpose. This is done by the engineer force, and it requires but a few minutes when the apparatus is installed; and it eliminates one source of filth and infection with a minimum expenditure of time and effort.

In the operating-room some additional apparatus was installed to insure the absolute daily disinfection of every article in use in the operating-room. With the modern pressure-steam dressing-sterilizer and instrument-sterilizer there is no longer

A rule was adopted that all basins, pitchers and trays used by nurses shall be cleaned and boiled for ten minutes after use, and then stored in formaldehyde solution 1-4000; also that this solution shall be changed daily. All bowls for solutions must be again boiled before using. A general rule was adopted that all apparatus used by nurses must be sterilized at least once daily.

A definite technique for the disinfection of the nurses' hands was adopted, as follows: The hands shall be scrubbed for three minutes with soap and water and a sterile nail-brush. The finger-nails shall then be cleaned with a sterile wooden nail-cleaner, and the hands shall be scrubbed again for three more minutes. The hands shall then be soaked in formaldehyde solution 1-500 or bichloride of mercury solution 1-1000, for two minutes.

As a further precaution against the possibility of infecting the skin of patients admitted to the hospital, in addition to preparing for the disinfection of the bath-tubs and the nurses' hands, a plan was adopted of having all patients prepared for operation during a certain period by a nurse assigned for that duty, called the preparing nurse, whose hands are thus kept from contact with septic material.

In applying the general principle of keeping the hands of the nurses free from septic material there were numerous details to be worked out, some of which have been met as follows: It is required that, after the usual daily cleaning by the ward maid, the door-knobs, window-sills, tables, chairs, bureaus, bedsteads, poles for douche-bags, and the tops of all furniture or objects in the wards or rooms, shall be wiped off with formaldehyde solution 1-500 by the nurse; also, that all shelving in the diet-kitchens and in the rooms in which the apparatus for nurses is kept, shall be washed daily; on alternate days with soap and water, and with formaldehyde solution 1-500.

Among other objects with which the hands of the nurses come in daily contact there are probably none which are more septic, if not absolutely dirty, as hospitals are usually con-

ducted, than the rubber sheets which are used to protect mattresses. The usual method of caring for these is to wipe them off when the patient is discharged and then to put them on another bed; and it is quite probable that even this wiping off process is often omitted. As these sheets necessarily receive discharges from the bowels, from the vagina, and from discharging wounds in many cases, from the necessities of the situation they must always be covered with pathogenic micro-organisms and are, therefore, a fruitful source of infection of the hands of nurses.

Such rubber sheets are treated by washing them thoroughly after use, after which they are soaked in formaldehyde solution 1-500 for twelve hours, wiped dry and put away in a sterile cloth, rolled on a roller, until used again.

The vomit-trays and pus-basins were eliminated as sources of infection of the nurses' hands by classing them with the other basins and trays in use, and having them cleaned and sterilized and stored in formaldehyde solution each time after use.

Another source of infection of the nurses' hands are the cans which are used to receive the dressings and waste from the wards. Such cans are in constant use in all hospitals, and receiving, as they do, septic dressings, they are a prolific source of infection of the nurses' hands. This source of infection was eliminated by requiring that the lids of the cans should be permanently removed, so that it is unnecessary for the nurse to touch the cans. When the cans are taken to the engine-room in order that their contents may be burned, they are cleaned, and then boiled in an apparatus installed for the purpose. This is done by the engineer force, and it requires but a few minutes when the apparatus is installed; and it eliminates one source of filth and infection with a minimum expenditure of time and effort.

In the operating-room some additional apparatus was installed to insure the absolute daily disinfection of every article in use in the operating-room. With the modern pressure-steam dressing-sterilizer and instrument-sterilizer there is no longer

any difficulty in adequately sterilizing dressings, instruments, towels, gowns, etc., but for convenience a large instrument-sterilizer similar to the ones designed for the sterilization of bed-pans, douche-pans, etc., was installed in the sterilizing-room, which will contain a sufficient number of basins, pitchers, etc., to furnish sterilized basins for a day's work.

A new apparatus was installed by means of which the hands of the surgeon and his assistants are washed in a spray of running water—the supply of water being controlled without using the hands. This apparatus eliminates the possibility of infecting the hands by washing them in septic basins.

In my judgment every hospital should install a plant which will sterilize its entire water-supply. Hospitals having a high-pressure steam plant can do this with very little expense by having the cold-water inlet-pipe pass through a cylinder sufficiently filled with copper tubes connected with the high-pressure steam plant to boil and sterilize the water on its way to the storage-tank. By regulating the size of this tank and the amount of heating surface in the copper coils to the daily amount of water used, it is a relatively simple mechanical problem to sterilize the entire supply of a hospital. An additional apparatus would be required to cool this water on its way to the storage-tank. Such an arrangement would not only assist in eliminating typhoid fever from hospitals, but would also be of material service in carrying out the principles of asepsis.

The plan so often followed in operating-rooms of using the same basins for several consecutive operations, merely washing them out between the operations, is reprehensible, and with the present facilities for sterilizing such apparatus there is no excuse for this bad custom.

The real difficulty in the sterilization of the apparatus in the operating-room was how to sterilize the irrigators, the slop-buckets, the Kelly rubber cushions, perineal pads, etc. This problem was satisfactorily solved with the assistance of a mechanical engineer. The largest slop-can, with the smaller put within it, is filled with water and by means of a metallic

connection with a high-pressure steam-pipe, live steam is turned into the water and the entire apparatus is sterilized by boiling. The Kelly pads are sterilized by soaking them over-night in formaldehyde solution 1-500, after thoroughly cleansing them. The problem of how to deal with irrigators was solved by using large rubber douche-bags, which are boiled each day before being used.

The points to which I would direct attention are:

1. Whether surgeons should be satisfied with the policy of giving verbal directions to head nurses about the disinfection of hospital apparatus and the technique of nurses as applied to the treatment of wounds; or, whether each hospital should adopt a routine technique which should prescribe the methods which are to be followed, thus avoiding any possibility of error on the part of the head nurse and pupil nurses.

2. The importance of preventing the infection of the hands of nurses by the elimination of all possible sources of contamination, through proper regulations as to the cleansing and disinfection of wards, rooms, furniture and apparatus employed by the nurses.

3. The adoption of a proper technique for the disinfection of nurses' hands.

4. The installation of proper sterilizers, which will enable nurses to sterilize the apparatus used by them as efficiently as is done in operating-rooms at the present time.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, April 25, 1906.

The President, DR. GEORGE WOOLSEY, in the Chair.

REMOTE RESULTS OF OPERATION FOR THE RADICAL CURE OF INGUINAL HERNIA.

DR. WILLIAM B. COLEY presented a young man upon whom he had operated fourteen years ago, by the Bassini method, for a left inguinal hernia which had existed since infancy. The hernia had been temporarily cured by a truss, but had relapsed. The operation had effected a perfect cure, and there were no indications of a recurrence at the present time. The operation had produced no effect upon the development of the testis. The patient was now married, and the father of two healthy children.

DR. JOHN B. WALKER presented a man upon whom he had operated ten years ago for a congenital left-sided inguinal hernia. There were no evidences of a recurrence up to the present time, but the patient had returned to be relieved of a hernia on the opposite side, which had recently developed as the result of a strain.

CARCINOMA OF THE MALE BREAST.

DR. WILLIAM B. COLEY presented a man, 64 years old, with a carcinoma of the left breast. The case was shown on account of the comparative rarity of this condition in the male, and because of the fact that it had existed for ten years, an unusually long period. The lesion was of traumatic origin, coming on two months after a blow from a crowbar. For four years it

slowly increased in size. It was then treated for about a year with applications of plaster, under the influence of which it slightly diminished in size. Since then the man had had no treatment. The lesion was more or less fungoid in its outer portion, and extended upward almost to the axilla. The axillary and supraclavicular glands were enlarged and hard. The man had been able to continue at his work, which was that of a laborer, until two months ago.

Dr. Coley said that this was the fourth case of cancer of the male breast that had come under his observation. In three of them there was a traumatic history. According to Roger Williams, the comparative frequency of this lesion in the male and female was as one to one hundred and seventeen, and in sixty per cent. of the cases there was an antecedent traumatic history. The duration of life averaged eight months longer in the male than in the female, and the number of cures following operation was comparatively small. In fourteen cases traced by Williams, only two remained exempt from recurrence.

DILATATION AND HYPERTROPHY OF THE STOMACH.

DR. CHARLES N. DOWD presented a woman, forty years of age, who was admitted to the General Memorial Hospital last January. For a year she had had gastric disturbance, which for several weeks had been extreme. Vomiting had been the most prominent symptom. This came at irregular intervals, usually after eating. The vomitus was usually sour undigested material, and on one or two occasions food returned which had been taken several days before. She was constipated, having one or two small movements a week, and she was much emaciated. The abdomen had become much distended, so that a diagnosis of large ovarian cyst had been made by more than one physician. She came to the Out-Patient Department of the hospital, and a stomach-tube was introduced and eleven pints of semifluid, very offensive material were withdrawn. A series of stomach washings was undertaken in the hospital to test the stomach's ability to empty itself, and it was found that although much of the food which was taken at supper could be withdrawn in the morning, the stomach would occasionally empty itself through the night. Analysis of the gastric contents showed absence of free hydrochloric acid and a

trace of lactic acid; total acidity, .2555; acid salts and organic acids, .1095; combined hydrochloric acid, .1450.

January 3d a gastro-enterostomy was done by the clamp method, attaching the uppermost part of the jejunum to the dependent part of the posterior stomach-wall. The stomach was so thick that it could not be held by the ordinary clamps which are used as an aid in sewing the stomach and intestinal walls together. The stomach-wall was about four times its ordinary thickness. The patient made an uneventful recovery; has gained very much in weight, and is now in good health. The condition was due to cicatricial pyloric stenosis, with no evidence of malignant growth.

ISCHÆMIC MUSCULAR ATROPHY.

DR. CHARLES N. DOWD said that in the April issue of the *ANNALS OF SURGERY* attention had been drawn to this condition by Dr. Ferguson, of Chicago. In the *Lancet* of January 11, 1902, there was an article by Dugeon, in which he reported four new cases and described eleven others, and there are many references to the subject in surgical literature under the terms Volkmann's contracture, ischæmic paralysis, ischæmic muscular atrophy, etc. It is certainly not pleasant to think that so serious a condition may result from a fracture treated apparently according to ordinary methods. Yet the patient which he now presented, was the second one who had been brought to St. Mary's Hospital with this condition during the year. The contracture ordinarily comes in children, and usually follows a fracture about the elbow-joint. In this instance, a child four years old, the fracture, just above the elbow-joint, occurred a year and a half ago. It was treated by putting the arm in splints and keeping it there for four weeks. After the removal of the splints only moderate stiffness in the elbow and fingers was noticed, but soon the fingers became more flexed, and inability to extend them was more noticeable. Their tips were drawn into the palm of the hand, so that the nails irritated the skin there. A sore also came on the tip of the little finger, which sloughed and healed at a later time. There was only moderate improvement for the following year, and when the child came to the hospital six months ago the fingers were contracted about half way to the palm, and could not



FIG. 1.—Ischæmic muscular atrophy with contracture of hand.



be extended unless the wrist was flexed, in which case they could be straightened, a characteristic symptom of this condition. The forearm was atrophied. The muscles on its anterior surface seemed hard. Sensation was good all over the arm, and the skin had almost a normal appearance, but was slightly glossy. The muscles all reacted to faradism. Supination was restricted to about half the normal amount. This symptom, the attending physician said, did not exist when the splints were first removed, but increased gradually.

The accompanying photograph shows the hand extended as far as she was able to extend it. She could flex the fingers so as to touch the palm. After consultation with neurologists, massage was used and was continued daily with much care for about three months, when she contracted measles. The gain under this treatment was so slight that it could not be appreciated. After her recovery from measles incisions were made to inspect the condition of the muscles and nerve. The flexor muscles of the forearm were found to be hard, fibrous, pale, and atrophied. The median nerve was somewhat pressed upon by the upper fragment of the old fracture, and seemed a little denser at the site of this pressure than below it. The musculo-spiral nerve seemed normal. The ulnar nerve was displaced, and lay to the inner side of the internal condyle instead of in the groove between it and the olecranon. No change in its texture could be distinguished. It was replaced in its proper position.

In the second case which has been treated in the hospital this winter a similar dissection onto the median nerve had shown that it was pressed upon by a sharp spicule of bone which projected from the upper fragment of the fracture. Sufficient time has not elapsed to determine whether the relief from pressure of these nerves will affect the contracture. The reports, however, from most of the cases which have occurred indicate that the lesion in the muscle cannot be ascribed to the nerve. Volkmann, in his original description, considered the muscle change to be due to anæmia, usually from splint-pressure, and this explanation has generally been accepted. In about half the cases which have been reported there are scars from pressure-sores over the muscles. A similar condition has been reported by Mr. Davies-Colley in the calf muscles from a fracture of the tibia and fibula and subsequent suppuration. In one instance a characteristic ischæmia

contracture of the forearm followed a bullet-wound in the axilla, with a thrombosis of the axillary artery. In neither of the speaker's cases has there been any evidence of a pressure-sore. The treatment which has been most successful is massage and tendon-lengthening. The speaker expected to lengthen the flexor tendons in this case unless improvement soon followed the massage.

DR. ROYAL WHITMAN said that the contraction was not entirely limited to the flexor muscles. In addition to the loss of supination and extension at the elbow, to which Dr. Dowd had referred, there was also some limitation of flexion at the wrist, the muscles on the dorsal surface of the forearm being somewhat shortened, as well as those on the flexor surface.

CHRONIC HYPERTROPHIC SYNOVITIS OF THE KNEE JOINT.

DR. JOHN A. HARTWELL presented a man, twenty years of age, who was admitted to the Lincoln Hospital on February 12, 1906, and gave the following history: In childhood he had some glandular enlargement in the neck, which required surgical attention. He had never been of a very robust type, but had been able to do hard work for several years past. About three years before admission, while jumping from a wagon, he sustained a slight injury of the right knee, which was not sufficient to cause disability at the time. The next day, however, the knee began to swell, and he gave up his work for four or five days, but was not confined to bed. Since that time he had worked continuously as an express-driver and handler, though his knee sometimes pained him a little, and was more or less swollen. For three weeks previous to admission these conditions had been rather more marked than before.

Physical examination on admittance to hospital: Appearance—Patient fairly well nourished; slightly anæmic; rather tubercular type. Heart—Normal. Lungs—Expansion poor; clavicles prominent; expiration prolonged at right apex; higher pitched; slight cogged-wheel rhythm. Abdomen—Negative. Glands—scar on left side of neck where glands were removed in childhood; otherwise glands not enlarged.

Extremities—Left shoulder slightly stiff, and painful on movement; right leg swollen at knee; not inflamed; no heat redness

nor pain when quiescent; all ligaments intact; movements restricted; flexion only to right angle; full extension possible; pain in the knee on walking; patella riding high; swelling laterally and up in cul-de-sac very marked; no movable bodies felt; no signs of fracture.

The extremities measured as follows: Right extremity—Calf, $10\frac{5}{8}$ in.; 6 in. above knee, $13\frac{1}{2}$ in.; above patella, $12\frac{5}{8}$ in.; over patella, $13\frac{3}{8}$ in.; below patella, $12\frac{3}{8}$ in. Left extremity—Calf, $11\frac{3}{8}$ in.; 6 in. above knee, $15\frac{1}{2}$ in.; above patella, $12\frac{1}{8}$ in.; over patella, $12\frac{5}{8}$ in.; below patella, $11\frac{3}{8}$ in.

The boy's general appearance, the scar of early glandular trouble in the neck, and the suspicious conditions found in the lungs, together with the very marked atrophy of the right thigh and leg, suggested the possibility of a tubercular synovitis. The absence of muscular spasm, of pain, and of any evidence of bone involvement after so long a history, argued, however, against this, and after ten days' rest in bed in order to allow the acute symptoms to subside, exploration was deemed advisable, and was done on February 20th, as follows:

After the usual preparation of the leg from the toes to the thigh an incision was made $3\frac{1}{2}$ inches long on the inner side of the patella. This was carried down through the skin and subcutaneous tissues, which were normal. Bleeding-points clamped. Incision was now made down through the joint capsule, which was found much thickened, and very vascular. Then the synovial membrane was opened. This was also very thick and succulent. Tissues cut with scissors to enlarge deeper cut to limits of skin incision. Joint cavity exposed and examined. Everywhere the synovial membrane was thickened with villous-like processes, and very vascular and inflamed. Bleeding-points caught as met. Ligamentum alaria especially inflamed. All the abnormal tissue now in sight was removed with scissors and forceps, including most of the ligamentum alaria. The joint was irrigated with hot saline solution. Leg was now flexed at the knee, and more of the fungoid material reached and cut away. Another irrigation followed. Tissue removed in notch down to crucial ligaments. Irrigation of the joint was again thoroughly accomplished. No disease of the bone found. Synovial membrane sewed up with continuous catgut suture, vessels being tied off with fine catgut. Capsule also closed with interrupted catgut;

skin with continuous silk. Rubber tissue drain carried down to the synovial membrane. Dressing applied, and leg put on posterior splint.

February 24th.—Rubber tissue drain removed. Wet dressing applied, because of a slight redness along the stitch-line.

February 26th.—Redness entirely subsided, and primary union resulted. The splint was removed on the twelfth day and passive motion of the joint allowed. Patient was allowed to walk on twelfth day and left the hospital three weeks after the operation. He returned to work on April 15th, about four weeks after the operation, and has had no difficulty with the joint since then. Examination at the present time, about five weeks after the operation, shows a normal functioning joint, with no effusion, and only a very slight thickening of the capsule. The atrophy of the thigh and leg, however, are the same as before the operation.

Pathological findings of the joint contents were as follows: Fluid consisted of blood-stained serum, with well-marked fibrin clot on standing. The cellular count showed: Polynuclear cells, 28 per cent.; small mononuclear, 6 per cent.; endothelial, 66 per cent.; red cells, 4 to 1 white. Section of synovial membrane shows thickening and hypertrophy of the membrane and fringes, due to (1) increased amount of fatty tissue; (2) new growth of connective tissue—*i.e.*, vascular and cellular tissue; (3) areas of small round-cell infiltration; (4) increase in depth of layer of marginal cells, closely packed connective-tissue cells, with little or no intercellular substance. No evidence of tubercular or purulent infiltration. Tissue and fluid were both found to contain no bacteria as tested by smears, cultures, stains, sections and injections into guinea-pigs.

Dr. Hartwell said he showed the case as one of chronic hypertrophic synovitis of the knee-joint, the lipoma arborescens of the German writers. The unusual features in the case, he thought, were the very marked atrophy where no actual disuse was present; the very good recovery following the operation, and the pathological condition within the joint, showing that these cases could probably be restored to health only in this way.

DR. ROYAL WHITMAN said he did not think marked atrophy was particularly unusual in cases of persistent synovitis, or in any affection of the joint. Atrophy incidental to disuse did not neces-

sarily mean disuse of weight bearing and motion, but rather a physiological disuse which affected the nutrition of the muscles.

DR. HARTWELL, in reply to Dr. Whitman, said that in his case the patient had apparently used the affected limb very actively. His work was that of an expressman, and he was constantly jumping on and off the wagon. According to the history, he did not favor the limb at all until just prior to his admission to the hospital.

SUBDURAL HÆMORRHAGE.

DR. JOHN A. HARTWELL presented a man, aged 49 years, colored, who was admitted to Lincoln Hospital on February 27, 1906, with the following history: On February 21 he was struck on the head by a large piece of timber falling from a height of one or two stories. He was knocked to the ground, was picked up unconscious and taken to the Lebanon Hospital in an ambulance. He regained consciousness in about twenty minutes, but was excitable and irritable. There was a large scalp-wound over left parieto-temporal region, which was sutured. He continued in his irritable and rather unmanageable condition during the next six days without, however, manifesting any focal cerebral symptoms. In addition to his irritability, he had had several attacks of vomiting. On his admission to Lincoln Hospital, six days after the injury, the following notes were made: Patient has a healed scar on the left side of his head, six inches long and curved like an operative incision. Patient seems drowsy, yet at intervals he is irritable, restless and unmanageable, trying to get out of bed. Patient does not respond to questions, and on being aroused, looks at one with a vacant expression. Heart, lungs and abdomen, all negative. Extremities: No change in sensations apparent. No paresis or paralysis. Reflexes, markedly increased. Control of bladder and rectum perfect. No facial paralysis or change in pupils.

Shortly after admission patient had a convulsion, which was reported by the attendant to be general in character. During the following three days the convulsions were repeated several times, were of very short duration, and no evidence that they were at all localized could be obtained. On March 2 these convulsions began to occur with great frequency, about every twenty minutes,

for periods of an hour at a time, followed by a period of rest. They were becoming longer in duration, and the following notes on their character were then made: First there was a vacant staring expression of the eyes, with a gradual conjugate deviation toward the left; after about four or five seconds there was a tonic contraction of the muscles of the left side of the face, then a drawing of the head downward on the left shoulder with an elevation of the latter; then tonic contractions in the arm, and then in the leg of left side. This phase occupied about fifteen seconds, and was followed by clonic spasms of the same parts and in the same order. The whole convulsion lasted from sixty to ninety seconds, during which the patient was totally unconscious. He then gradually regained consciousness and the contractions ceased. At this time, when he had had altogether about twelve convulsions, he for the first time showed a decided left facial paralysis and marked weakness of left arm and leg. This was on the ninth day after the injury, the first convulsion having been noted on the seventh. On the eighth day his condition was apparently improved. Operation was performed March 2, nine days after the injury, and as soon as the localized character of the convulsion and the paralysis was evident. Under ether, a curved incision was made just above the right temporal ridge, about eight inches in length and carried directly down to the skull, the flap being turned downward. The fissure of Rolando was now marked out, and a trephine opening made over the face center and enlarged upward with the trephine to an area of about two inches in diameter. The dura showed no pulsation, and a clot could be seen beneath it. Dura was divided around the line of the bone opening, and a large organized clot was removed from the cerebral cortex. Electrodes applied to the facial center produced a prompt contraction of the muscles of the face on the left side. No response could be obtained in either of the extremities, possibly because the nerve-cells here were too much damaged by the compression, though the paralysis of the face had indicated a greater involvement of the cells for that part. Inspection, however, indicated that the cells for the arm were more damaged than those of the face. The opening in the skull was hardly extensive enough to reach the leg center. The dura mater was closed with catgut sutures, a small, rubber tissue drain put down through it, and the scalp sutured back in place. It was noted

that the scalp was quite œdematous, probably due to lymphangitis following the original scalp-wound.

Postoperative notes: March 4—Recovered from anæsthetic without incident. Slightly excited during first twelve hours and then became rational, but continues rather stuporous. Can be aroused, and gives correct account of injury and other details of his residence, work, etc. Still has considerable weakness of left upper extremity, and less of the lower extremity. Is able to make coördinated movements. Slight spasticity of lower extremity left side, none of upper. Left-sided facial paralysis, and left deviation of tongue. Upper branch of facial less paralyzed than lower. Examination of reflexes unsatisfactory. No ocular paralysis.

March 6.—Patient less rational than formerly. More stuporous. Complains of pressure on head. Very restless. Left arm can be moved only with great difficulty. Face more markedly paralyzed. Wound examined and pus found along the suture line. Considerable distention. Opened after stitches were removed. Infection all through the scalp, due to previous lymphangitis. Pus infiltrating tissues down to the dura. Dura thickened and brain apparently well walled off by dense adhesions. Wound area opened up widely and dressed with free drainage and bichloride solution.

March 9.—Wound very much cleaner. Both sides granulating well. In center, still suppurating. Left arm can be moved more freely.

March 11.—Wound granulating well. Patient more rational. Movements on left side stronger.

March 13.—Patient improves slowly. Mind brighter. Movements of left side gradually returning. Can put left hand to nose and mouth with effort. Cannot hold up a single finger of left hand.

March 15.—Wound granulating well. Pulsations fair. Complains of being in bed. Left facial paralysis less marked. Can nearly hold up finger of left hand.

March 27.—Wound granulating well; nearly free from pus. Mental condition practically normal. Left leg can be used nearly as well as the right. Left arm not so powerful as right. Power of coördinated movements not entirely regained. With eyes shut, fingers do not meet by several inches. Left not so strong as right.

Facial paralysis still slightly present on left side of face. Left eye cannot be shut tight. Left angle of mouth can be drawn back but a very little.

April 10.—Patient was discharged, forty days after the operation. Wounds entirely closed, but still showed slight incoördination of left side of body, and slight left-sided facial paralysis. He walks without any dragging of the foot. Mentally, he is normal.

April 25.—Eight weeks after the operation there is absolutely no evidence of his injury remaining except the scars on his head, and the brain pulsation beneath the opening in the skull. There is no evidence of any irritability of the brain due to adherent dura.

THE ADVISABILITY OF EARLY OPERATION IN INTRACRANIAL HÆMORRHAGE OF TRAUMATIC ORIGIN.

DR. FRANK W. MURRAY read a paper with the above title (for which see page 374).

DR. JOHN A. HARTWELL said the condition of intracranial hæmorrhage of traumatic origin, which Dr. Murray had discussed in his paper, was constantly coming under the observation of the surgeon, especially in hospital practice, and it was often very difficult for him to decide what to do. The problems that confronted the surgeon were whether the condition was sufficiently localized to admit of operation, and, furthermore, whether he would be able to locate the site of the hæmorrhage.

In a case reported at one of the previous meetings of the Society, Dr. Hartwell said, the patient, a child, was brought to the hospital in a semi-comatose condition as the result of a fall on the head. Within thirty minutes after admission, the coma was complete. There were no localizing symptoms, and in their absence, Dr. Hartwell decided to do the decompression operation as described by Cushing, turning down the fascia of the temporal muscle, splitting the muscle, and then trephining over the so-called "silent area." The dura was found much distended, and upon incising it, serosanguineous fluid spurted out with considerable force. The brain was œdematous in appearance, and there was no pulsation in it for several minutes after opening the dura; then the pulsations returned, and its appearance became normal.

The intracranial pressure was so great that it was impossible

to suture the dura in its normal position. The muscles, however, were sutured, and the child made an uneventful recovery, and two and a half months later showed no evidence of trouble from the loss of bone and dura. Prior to the accident, the child had been slightly deaf on the affected side, and subsequently that defect became more pronounced.

In the second case reported by Dr. Hartwell, the patient, after a fall of six or eight feet, sustained a very severe injury of the head. Upon examination, he had a large hæmatoma of the skull, but there were no signs of fracture. Upon operation, a large subdural hæmorrhage was found, extending over the whole surface of the brain. The patient died shortly afterwards, and at the necropsy, a slight fracture at the base was found. The symptoms in this case were those of severe concussion, which was practically caused by multiple minute hæmorrhages from the small vessels of the brain.

Dr. Hartwell said he agreed with Dr. Murray that if these cases were more carefully watched, many could be saved by early operative interference. Operation was too often neglected because of the absolute absence of localizing symptoms.

DR. GEORGE WOOLSEY said he was interested in the statement made by Dr. Murray in regard to the relative number of cases in which there was no actual injury to the brain, only the compression from the clot. In many cases there were no localizing symptoms, and sometimes it even could not be determined whether or where a blow had been struck. In these cases of head injury, neurologists were rather inclined to attribute the symptoms to actual laceration of the brain, and were rather disinclined to advise operative interference. Personally, Dr. Woolsey said, he favored an exploratory operation in every instance where there were any focal symptoms of pressure, or where there was a localized injury with general pressure symptoms.

Last summer, Dr. Woolsey said, a boy was brought to the hospital after having sustained a fall from a fire escape. He had mild convulsions, with intervals of semi-coma, there was a moderately slow pulse, and some symptoms indicating brain-pressure. An operation was done, and upon incising the dura, no hæmorrhage was found, but there was an increased amount of cerebro-spinal fluid, and the surface of the brain was boggy and œdematous. The evacuation of the cerebro-spinal fluid gave

the patient some relief, and he eventually made a good recovery. In that case there were no evidences of a clot to account for the symptoms.

DR. MURRAY, in closing, said a history of trauma was one of the most important factors in deciding the surgeon to operate. Of course, where there was depression of bone the indications for surgical interference were clear, but in many of these cases there was simply a hæmatoma. In cases of subdural hæmorrhage where the coma often persisted for days, and in dealing with which the attitude of most surgeons was very conservative, the speaker thought that an exploratory operation was advisable, in spite of the old idea taught in the text-books that most of those cases would recover without operation. The chief points that influenced him to operate on such a case were the appearance of choked disk, slow pulse, and increased blood-pressure as indicated by the manometer.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting, May 7, 1906.

The President, JOHN B. ROBERTS, M.D., in the Chair.

OSTEOTOMY FOR ADOLESCENT RACHITIS.

DR. JAMES K. YOUNG presented a lad, fifteen years of age, who was admitted to the Polyclinic Hospital June 10, 1905, with a well-marked genu varum of the left leg, which had developed during the preceding three months. The shortening was considerable, and he wore a high shoe until the time of the operation. He sought relief from the pain and disability caused by the deformity in the joint. The point of greatest deformity in the bone was just below the tuberosity of the tibia.

Osteotomy of the tibia and fibula was performed at the point of greatest deformity. He was dressed in a fracture-box with compresses, and the recovery was uneventful except for a consecutive hæmorrhage which occurred from the fibular wound. Dr. Young said that osteotomy at this point is exceedingly difficult, on account of the danger of wounding the anterior tibial artery, the peroneal nerve, and the posterior tibial artery, and also because the section has to be very freely made on account of being very near the joint, but the result of the osteotomy in this case is perfect.

ANASTOMOSIS OF THE EXTERNAL AND INTERNAL POPLITEAL NERVES FOR INFANTILE PARALYSIS.

DR. JAMES K. YOUNG reported the case of a girl seven years of age, who applied to the Polyclinic Hospital November 29, 1904, on account of infantile paralysis of the left leg.

When two years old a paralysis of the left leg developed, so that she could not walk for six weeks. Was taken to various hospitals and treated by electricity and massage, after which she was enabled to walk. Had had no treatment for several years. She was a well-nourished child, well developed for her years. Left leg showed shortening, and there was a limp present in left leg.

Measurements—

Right leg....Length, 23 in. Calf.... $9\frac{1}{2}$ in. Thigh.... $12\frac{1}{2}$ in.

Left leg....Length, $22\frac{1}{4}$ in. Calf.... $6\frac{1}{2}$ in. Thigh.... $11\frac{1}{2}$ in.

The entire distribution of the motor-tract of the external popliteal was paralyzed except the extensor longus digitorum, which showed a very feeble power of extension, only to be detected by careful observation. Sensation was normal.

Operation of nerve anastomosis, suggested by Dr. Wm. G. Spiller, was performed December 8, 1904. The operation consisted in a total central peripheral transplantation of the external popliteal into the internal popliteal nerve.

The technique of this operation does not differ from that employed in nerve anastomoses of other parts. The object sought is to transplant the nerve in such a manner as to place the central nerve axis of the paralyzed nerve in the same direction as the central nerve axis of the sound nerve.

The region was exposed by an incision six inches long, beginning at the middle of the posterior aspect of the thigh and terminating at the inner side of the biceps tendon. The external popliteal was first exposed and then the internal popliteal. The external popliteal was divided and attached to an incision in the internal popliteal. It was held in place by three chromicized catgut sutures. The wound was closed with catgut sutures and dressed in a plaster-of-paris case.

Sensation in the toes over the distribution of the musculo-cutaneous nerves returned in twenty-four hours. For three months afterward there was no improvement in the motor power or in the growth of the limb. Growth was then resumed and has since continued uninterrupted and more rapid, and the circulation has improved. There has been no loss of power in the extensor longus digitorum, but a slight increase of function, and the limb is more useful than before the operation.

DR. WILLIAM G. SPILLER said that in this case in which only a little motion was preserved in the extensor longus digitorum before operation, the question arose as to whether the nerve in this muscle should be sacrificed. As only slight power persisted it seemed proper to sacrifice the nerve. It would not be destroyed by the operation, but its power would be distributed over the entire region of the popliteal.

DR. YOUNG, in closing, replied to a question as to whether the operation of anastomosis was of value in cases in which distinct reactions of degeneration were present. Dr. Young was at one time extremely doubtful that benefit was derived from anastomosis in such cases. After hearing Hoffa's statements at Atlantic City a few years ago he is inclined to believe that restoration is possible even when the reactions of degeneration are present. The appearance of the muscles themselves is the best guide to prognosis in these cases. The color varies from a dark red to pink or to a yellow tinge. The last indicates that the muscle is fatty; in these the reactions of degeneration are most marked. The reactions are in all cases difficult to determine, as admitted by neurologists, and may in some instances not be obtained. One is not sure that degeneration is not present even when the reaction is lacking. As to the technic of anastomosis, some surgeons do not employ sutures in the sheaths of the nerves. Dr. Young prefers to pass the anastomosing nerve entirely through the opening in the other and then suture at three points. The nerve then falls back until the ends of the axis-cylinders are in direct apposition with the same structures in the sound nerve. The new nerve in this way grows directly into the central axis of the sound nerve. The placing of three sutures refers only to nerves large enough to accommodate so many; in small nerves two or even one will have to suffice.

THE RELATION OF THE TECHNIQUE OF NURSES AND OF HOSPITAL APPARATUS TO THE HEALING OF WOUNDS.

DR. CHARLES P. NOBLE by invitation read a paper with the above title (for which see page 431).

DR. GEORGE ERETY SHOEMAKER said there was possibly a needless elaboration in some of the points detailed by Dr. Noble,

but at the same time there is no doubt that surgeons cannot be too careful in securing asepsis. Boiled rubber gloves for the nurse who is preparing the patient solve some of the problems. A source of infection in operative cases is the slipping of the dressing applied by the nurse after preparing the operation site. This is especially true in cases in which plastic precede abdominal operations. He believes the free use of formalin as recommended by Dr. Noble will be found to cause a dermatitis in some nurses. In the hospital where he does much of his work they put a formalin solution in the wash-basins of the operating-room one hour before using them, but the hands are washed in running water. The stationary wash-basin may be a prolific source of infection.

DR. JAMES K. YOUNG remarked that nothing had been said by Dr. Noble regarding the use of gloves. He always uses rubber gloves and thus eliminates one source of infection.

DR. GWILYM G. DAVIS regards the boiling of basins as a perfectly satisfactory plan. At the Orthopedic Hospital they use a large, square, steam-heated box for this purpose. He prefers that the nurses in the operating-room should wear gloves, just the same as do his assistants. As to the dirty basins for washing the hands, that feature can easily be avoided by the use of running water and the rose spray.

DR. JOHN B. ROBERTS said an important point in this question of asepsis seems to be that no one can do good surgery unless he is in absolute control of a hospital. The value of this feature is shown by the excellent suggestions of Dr. Noble. Such details as he enumerates cannot be carried out in a hospital where four or six surgeons change at intervals, as in one institution with which Dr. Roberts is connected. The preparation of the nurses is an important part of surgical technique. In this connection it may be said that practically all surgeons are guilty of hurrying the nurses and not giving them time properly to attend to aseptic technique when an operation is at hand. In addition to those already named, a source of infection is the exposure of wounds often seen during ward visits. This is particularly true of wounds about the groin or in other places difficult to bandage, the wound being uncovered by the slipping of the dressing improperly applied by the resident who dressed the case.

DR. NOBLE, in closing, said he was not at first prepared to believe that infection of wounds came from infection of the skin

before operation, but a series of infections had conclusively proved its possibility. As to Dr. Shoemaker's statements regarding the impracticability of formalin, all the nurses in his hospital have used it for some years. Two or three thought it caused dermatitis. They were permitted to substitute bichlorid for the formalin. There is no difficulty with its use except in cases of idiosyncrasy. Regarding sterilization of the waste-cans in the wards, if one sees how easy it is to do this he would no longer be willing to let them go without it. Dr. Noble has for years used rubber gloves. They are of great value in keeping the surgeon's skin from infection, and also for protecting the wound, thus working both ways. He wears them in all except trifling operations. The rose spray installed in the hospital as described by him is the same type as mentioned by Dr. Davis. It can be manipulated by the feet or by the elbow of the surgeon. It works by an ordinary lever pressed in by the feet, the latter being aided by a catch which holds the lever open after it is pressed by the foot. To mix the water properly there is an ordinary valve shut-off on both hot and cold supply-pipes. In manipulating the flow of water in any way desired, the surgeon does not need to use his hands at any time.

DISLOCATION OF A VERTEBRA.

DR. EDWARD MARTIN (and by invitation, DR. WILLIAM G. SPILLER) reported the case of a boy, an athlete, who was wrestling. His opponent was holding him with his head on the ground and endeavoring to force down his shoulders. Suddenly the boy collapsed and became totally paralyzed. When he was examined there at once arose the question of operation. There was evidence of either a total transverse lesion or of a twist or stretch of the cord. It was decided to wait until this point was decided. The persistence of the paralysis for three days furnished proof of a total transverse lesion. Whether it was due to a dislocation of a vertebra or to a tear could not be determined. X-ray examination was unsatisfactory, but seemed to show a lesion of the sixth cervical vertebra. Laminectomy appeared to offer nothing, and hence it was not performed. In spite of all that is said to the contrary, laminectomy is not a safe procedure. If, however, his neck was injured in this way, Dr. Martin would like the operation done. It gives a possible chance

of replacing a bony fragment or of removing a clot, and at least would hasten death if it did not relieve. Dr. Martin's experience with laminectomy is that improvement after the operation is the same as occurs in cases treated without operation. The lesion in the case reported proved to be a luxation of the seventh cervical vertebra which had been spontaneously reduced, there being no fracture and yet a complete transverse lesion of the cord.

DR. SPILLER said that when he examined the young man, a few hours after the injury, there was complete paralysis of the lower extremities. Sensation was completely lost as high as the umbilicus, and there was a zone of disturbed sensation between the umbilicus and the nipple line, by the following day the area of anæsthesia had extended as high as the third rib. The reflexes were entirely absent in the lower extremities. There was voluntary movement of the shoulders, the elbows, and the wrists. There was no grasp in the right hand and but little in the left. The signs were those of complete transverse lesion of the cord, and the level of the lesion was easy to determine. The disturbances of sensation on the inner side of each upper limb and the loss of power in the muscles of the hands—*i.e.*, in the distribution of the first thoracic and eighth cervical roots, pointed to a lesion in the corresponding segments of the cord, and hence the case was perfectly clear. All who saw the patient agreed that operation was not advisable. The question of operating in these cases is now greatly in dispute. Dr. Spiller is conservative in this regard and doubts if laminectomy is of value in fracture of the vertebræ. Some surgeons say that the chief cause of the paralysis is pressure by displaced bone and that restoration of function will follow removal of the fragments. As a matter of fact there is not extramedullary hæmorrhage in most cases. Usually there is disturbance of the cord due to the injury that produced the fracture, and whatever damage may have been done by displaced bone has occurred at the moment the displacement occurred. When the cord is thus injured no removal of pressure, if this exists, can restore it. In most instances the cord is mashed, and often there is softening and even hæmorrhage within the cord when the cord externally appears normal. Autopsy in the case under discussion showed there was no hæmorrhage on any part of the cord, either external or internal to the dura. At the eighth

cervical segment was marked compression of the cord, with swelling above and below. Microscopically marked degenerative changes are present in and above the compressed area, hæmorrhage within, and intense disintegration of the cord being shown. This same condition is found in many of the cases of similar injury to the cord. There is also some change in the sacral region in this case and Dr. Spiller is inclined to believe there was a temporary dislocation in the lumbar vertebræ, although this was not suspected before death or at the necropsy. The lower end of the cord is partly separated from the rest or reduplicated. This is possibly a congenital malformation.

DR. WILLIAM J. TAYLOR said that he had now under his care a man who eighteen months ago fell 42 feet, this rendering him unconscious for several hours. He was paralyzed for six weeks after the accident, when Dr. Taylor first saw him. By the X-rays it was thought possible to detect a fracture-dislocation of the first lumbar vertebra. The patient was put on the table in preparation for laminectomy, but a careful examination before ether was given revealed slight motion in one leg. The operation was not done and a plaster jacket was applied. The patient has continued improving up to the present time. He was in the hospital from September to February. He now has perfect motion and has no difficulty in walking. The greatest trouble now is when he leans over with the knees fixed, as this gives him intense pain down both thighs. The pain is not noticed if the knees are bent at the time he stoops.

DR. JAMES K. YOUNG said he had under his care for many years a girl who showed the happy results of laminectomy. She was an aeronaut who fell 100 feet and sustained a fracture in the lower dorsal region and was operated upon by laminectomy by the late Dr. Ashhurst. He took the chances of operating and removed a fragment of bone. The patient is now able to walk. There is of late years a tendency among surgeons not to operate upon cases of tuberculous paraplegia. Dr. Young does operate upon such cases. One patient referred to him by other surgeons now, as the result of operation, has the use of her limbs.

DR. CHARLES H. FRAZIER said regarding the etiology of the injury in the case reported, Dr. McKenzie, the physical instructor, stated that at the time of the accident the boy was much fatigued

from long-continued exercise and wrestling, and he believes the muscles failed to give proper support to the parts involved. Dr. McKenzie does not know of any other case of like injury.

DR. MARTIN, in closing, said the possible lesion in the lumbar region would help explain one puzzling symptom. In the case of a lesion high in the cord there should be incontinence rather than retention of urine. Here there was retention, which was suggestive of a lesion in the lumbar region.

AN EXPERIMENTAL STUDY OF SUTURE OF ARTERIES, WITH A DESCRIPTION OF A NEW SUTURE.

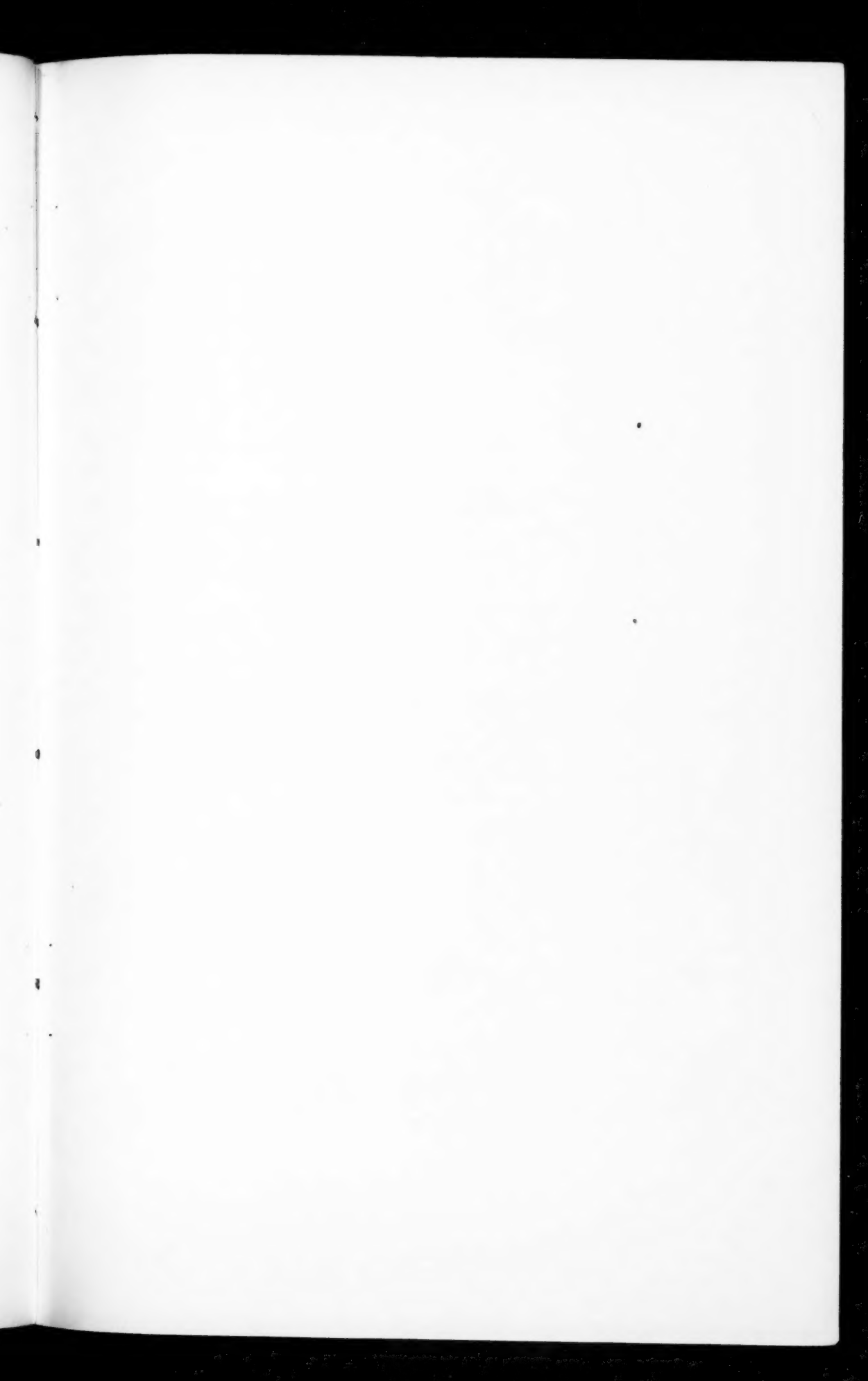
DR. GEORGE M. DORRANCE by invitation read a paper, with the above title (for which see page 409). He exhibited a series of specimens and demonstrated the application of the suture.

PERFORATION OF SKULL BY IRON ROD.

DR. C. G. ROSS reported the case of a man who was brought to the hospital March 20, with the history of having been struck over the leg center of the left side of the head by the end of a three-eighths-inch steel rod six-and-one-half feet long, which fell fifty feet. The pupils were dilated and did not react, and vomiting had occurred. There was doubt as to the advisability of immediate operation. The man did not develop convulsions. Operation was finally performed and showed that the iron had made a round hole in the skull as accurately as it could have been done by a trephine. The superior longitudinal sinus had been entered, but the button of bone prevented hæmorrhage. The inner table of the skull was compressing the leg center. When removal was accomplished, hæmorrhage was severe, and packing had to be kept in for seven days. When the packing was removed, motion in the leg was possible, and the man finally walked out of the hospital.

ENDOTHELIOMA OF THE CAROTID GLAND.

DR. J. CHALMERS DACOSTA read a paper with the above title (for which see page 393).



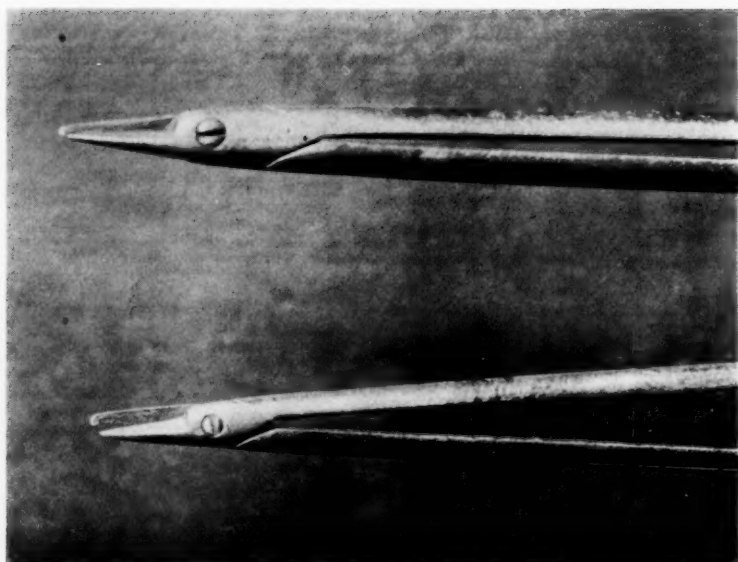


FIG. 1.—Scissors with one blade blunt pointed and hooked for removal of invisible or deep sutures.

SCISSORS FOR THE REMOVAL OF DEEP-SEATED INVISIBLE SUTURES.

DR. GEORGE ERETY SHOEMAKER exhibited scissors (Fig. 1) for the removal of deep-seated invisible sutures. He said that the suture or ligature which passes through dense structures in the lower part of its path is apt to bury its superficial portion with the knot, especially when tied upon mucous surfaces. There are certain localities, such as the rectum, the upper portion of the vagina, certain deeper parts of the wound in operations for gall-bladder drainage, and after vaginal hysterectomy, where ligatures or sutures may be almost or quite invisible and, because of distance from the operation, difficult to remove. The inside sutures of a properly-conducted Emmett operation for perineal repair are difficult to reach without such stretching of the parts as will imperil the recent union. For a number of years he had used scissors which safely remove such sutures, without laceration or over distention of the parts. These differ essentially from others having a hook on one or both blades, and may be described as follows: One blade has a blunt or probe point turned up not more than a twelfth of an inch, or to a point in a line with the back of the other blade when closed. The second blade is so much shorter than the first that there is just room for a silk wormgut suture to lie in the grasp of the hook, without being thrown out as the scissors are opened. The entire length of the instrument should be at least six-and-a-half inches. In order to use these scissors successfully, one end of the suture only should be left long after tying, the other being cut off close to the knot. For removal this long suture end is grasped and put upon the stretch, thereby furnishing a guide for the point of the scissors down to the loop to be cut in the depths of the part. The scissors, being slid along this guide, are introduced closed like a probe into the loop of suture, which is readily found when under the tension described. The suture is engaged in the hooked blade with the scissors still closed. The latter are then moved a little to one side to avoid cutting a knot. The tension is now removed from the long suture end previously held taut, and if the hook does not at once become disengaged it is evident that it is within the real loop of the suture. The scissors may now be confidently opened and shut, as the short blade does not throw out the suture, which

will now slip between the blades and the entire suture may be drawn out by the long end above referred to.

The important points are, that the scissors should be introduced closed, that no part of the hook should be sharpened, and that all edges be somewhat dull, in order that the suture may not be prematurely cut while feeling for the proper adjustment of the loop.

These scissors were made for him by Mr. Gemrig about ten years ago and have been used with great satisfaction ever since, particularly after vaginal hysterectomy and perineal operations.

TRANSACTIONS
OF THE
CHICAGO SURGICAL SOCIETY

Stated Meeting, April 6, 1906.

The President, DR. D. A. K. STEELE, in the Chair.

TABETIC DISEASE OF KNEE-JOINT.

DR. DANIEL N. EISENDRATH presented two cases of tabetic disease of the knee-joint, one in a woman, aged forty-five, and the other in a man, aged sixty. In both cases the most marked pathological feature was the enormous enlargement of the lower end of the femur, as shown by the X-ray. In one case this was so marked as to simulate an osteosarcoma of the lower end of the femur (see Fig. 1). This latter patient had been sent to the speaker with such a diagnosis. Examination of the patient, however, confirmed the diagnosis of tabes dorsalis. Another interesting feature of both cases was a marked increase in lateral mobility, especially in an outward direction. This was due to the enormous distention of the capsule, and subsequent stretching of the ligaments. Operative treatment had been advised in both cases, on account of this laxity of the joint. Resection of the ends of the bones was indicated in preference to amputation above the knee. A number of cases have been reported in which such typical resections have resulted satisfactorily.

Dr. Eisendrath also showed a patient upon whom he had performed nephrectomy for unilateral septic nephritis.

THE TECHNIQUE OF OPERATIONS UPON THE HEAD AND NECK.

DR. GEORGE W. CRILE, of Cleveland, Ohio, read a paper with the above title.

DR. ARTHUR DEAN BEVAN said that he had seen Dr. Crile operate on a neck case a short time ago, at the Lakeside Hospital, in Cleveland, when he employed the general technique which he had described, such as the elevated position of the patient's head, with rubber suit, etc., and with this elevated position of the patient's head the speaker was sure that the field of operation was maintained in a condition where there was much less blood, and where the dissection was much easier than in any case of neck work he had ever seen.

He had not had the opportunity to use temporary clamping of the common carotid artery in any of his surgical work on the neck. He expressed himself as having been a pessimist (and he was not at all proud of it) as to the general proposition of carcinoma of the head and neck with glandular involvement. He thought his position was now about what Dr. Crile's had been in the past as to the results which could be obtained by radical surgical treatment. His own surgical results had certainly been discouraging when there was evident glandular involvement in carcinoma. He was quite sure, however, that the position which Dr. Crile had taken was the correct one, as had been demonstrated without much doubt in connection with carcinoma of the breast, namely, that if we were to obtain radical results by surgical means, the operations must be exceedingly radical; that the operation must be so wide and sweeping as to remove the regional involvement, or else we would sooner or later get a recurrence.

He had been impressed with the desirability of the point which Dr. Crile mentioned in connection with the removal of the internal jugular vein in a number of these cases. He knew that in some of his earlier work he had attempted to leave the internal jugular vein and to dissect out the glands in close contact with it, which were grossly involved—a very stupid error, he now thought—and yet he had been governed by an early bias which led him to attach too much importance to the jugular vein as an important part of the economy. The internal jugular vein undoubtedly could be removed with little more risk than was involved in the



FIG. 1.—Tabetic disease of knee-joint.



FIG. 2.—X-ray of a tabetic knee-joint. Note the hypertrophic condition of the internal condyle of the femur which simulated a neoplasm.

removal of the external jugular vein, although, of course, there was a certain mortality from its removal. This, however, was very small.

He had never employed the method which Dr. Crile suggested in regard to giving the anæsthetic in these cases. It impressed him very favorably. He had employed a somewhat similar scheme of using rubber tubes through the nose down to the epiglottis, and walling off with large pads in sponge holders in front of the epiglottis, without packing the pharynx, as Dr. Crile had suggested.

He had been very much impressed with one point in connection with carcinoma work generally about the face and head, and that was the desirability of ligating the external carotid. He had been a little afraid to interfere with the common carotid, but as almost a routine in his work he had ligated the external carotid in extensive malignant disease of the face, with some considerable satisfaction.

DR. E. WYLLYS ANDREWS said that to understand the work of Dr. Crile, it was necessary for surgeons to read his other contributions to the literature on this subject in the last few years, and particularly in the last year. He had known about this temporary clamping of the carotid artery for several years, but had never dared to resort to it himself, because he had not actually seen it used.

It was perfectly obvious that Dr. Crile had started out in a direction where there was absolutely no precedent in the kind of work he was doing on the head and neck. He had created a new field of surgery here. Anyone who would review the literature of the last few years must come to the conclusion that it was almost revolutionary. The comparison that Dr. Crile made with the Halsted operation on the breast and his operations upon the neck explained a great deal. The radical breast operation, as advocated first by Willy Meyer and later by Halsted, put breast surgery on a new status, and Dr. Crile had created a new surgical status for the neck and head. The surgery of these parts was exactly parallel in laying great emphasis on dealing with the lymphatics.

The speaker felt that his own work had not been radical enough. He had tied one of the carotid arteries many times, dissecting half of the jaw or face, cutting down, and thinking that

the only way to make the operation feasible was to tie the common carotid, thereby getting a high mortality, but finally ending by doing no such radical and successful work as had been accomplished by Dr. Crile in the remarkably ingenious steps which he had described. To think seriously, many novel things had been presented by the essayist. Three or four of the steps he had described were entirely unknown until brought out by him, as, for instance, taking off the sternocleidomastoid, sacrificing it, and liberally sacrificing the internal jugular vein all the way up, reflecting the great skin flaps, exposing the field away beyond the line where the normal glands lay, discovering the easy line of cleavage in this deep plane.

DR. A. J. OCHSNER said that some five years ago he had had the good fortune of seeing Dr. Crile work for three days. He also saw some of his early work in this field. Since that time he had employed Dr. Crile's clamp in a number of operations, and had used the position which he had demonstrated, and had borne in mind one of the features which Dr. Crile pointed out at that time very forcibly, but which he only hinted at now, and which was of very great importance, especially in operations for the removal of portions of the thyroid gland in cases of exophthalmic goitre. In that particular class of cases it was of especial value, namely, after thoroughly anæsthetizing the patient, elevating the head and leaving the patient in this position during the operation, one could readily complete the operation without any further use of the anæsthetic. The anæmia of the brain which occurred as the result of this change of position would cause the amount of anæsthetic which had been given previously to suffice for the entire operation. He believed that this one point now did away with the necessity of operating upon these patients under cocaine. The comfort of an excision of an exophthalmic goitre was tremendously increased by the method which Dr. Crile had introduced, in that the patient was thoroughly under the anæsthetic until the surgeon reached the point of separating the gland from the trachea. About that time the patient began to speak, so that the surgeon had the comfortable feeling of knowing that he had not injured the recurrent laryngeal. Hæmorrhage was controlled, the ligatures applied, and the patient placed in a horizontal position again, and, if necessary, an anæsthetic could be given for suturing the skin wound. Since he had learned the

application of this method to this one operation, he had gotten a lot of comfort out of it. These little clamps were very satisfactory; and from an examination of the retractor which Dr. Crile had shown, he was sure that he should use it hereafter, as it was much better than the bent spoon handle, or a similar retractor, in that it was out of the way and still did the work effectively. The dental instrument was an ingenious contrivance.

DR. M. L. HARRIS said that without a practical knowledge of regional anatomy the valuable points which Dr. Crile had presented could not be clearly understood, nor their importance realized. A thorough knowledge of the lymphatic glands of the territories which were drained into certain lymphatic areas was of great importance. This was no better shown than in the difference in mortality rate from metastases which were found in cases of carcinoma of the lip and of the tongue. It had long been known that carcinoma of the tongue was much more malignant than carcinoma of the lip, and that operations for the removal of carcinoma of the tongue were much less successful than those for the removal of carcinoma of the lip. This was due largely to the lymphatic distribution. The lymphatics from the lip, for instance, converged to a more central point than do the lymphatics from the tongue. From the tongue the lymphatics pass to glands at the base of the tongue and the submental glands, to those in the upper triangle and to others as low down as the omohyoid muscle.

He emphasized the importance of removing the jugular vein in malignant diseases in these cases. This was again impressed upon him only recently. Two weeks ago he did an operation for carcinoma of the larynx, removing the glands in that vicinity. In removing the metastases in the glands of the neck he had to take away also all the vessels, namely, the common carotid, the external and internal carotid, and the jugular vein, in one mass. On examining the specimen subsequently to satisfy himself whether he had really done right in taking out so much of the blood supply, he was surprised to find on the inner wall of the internal jugular vein a small metastasis. He thought it was perfectly easy to leave such a metastasis. This case impressed upon him the great importance of sacrificing these vessels when necessary in these cases.

A German author, two or three years ago, in commenting on

the removal of the internal jugular vein, stated that statistics showed that the removal of the right internal jugular vein was five times more liable to be followed by brain trouble than the removal of the left, because of the fact that the left jugular foramen, at the base of the skull, was abnormal in size five times oftener than the right. In other words, the right internal jugular vein was larger and more uniform in size. He wondered if Dr. Crile had noticed any difference in the mortality on that account.

The little points of technique in the removal of the Gasserian ganglion would be appreciated by everyone who had done this operation, and, personally, he was indebted to Dr. Crile for bringing them out. This was particularly true as the surgeon had to operate in a limited space, and the bottom of the field of operation was consequently relatively very deep. Dr. Crile had spoken of placing forceps on the nerves, but this Dr. Harris thought took up more or less room, and he had found it of advantage to pass a silk ligature around the nerves, which enabled him to get rid of the forceps, and the nerves could be followed up without the interference of the forceps.

DR. DANIEL N. EISENDRATH asked Dr. Crile: First, after releasing the clamp following the temporary closure of the common carotid artery, to what extent did hæmorrhage follow the taking off of the clamp again from the terminal branches of the arteries? Second, in what percentage of his cases, if any, had there been cerebral embolism following temporary ligation of the common carotid? Third, whether he had ever performed a preliminary tracheotomy, or tracheotomy at any stage, at the time of the operation, or say a week before as a preliminary step?

He debated that question a good deal with himself lately in two cases of carcinoma of the tongue, one of which was an extensive carcinoma of this organ which was not brought to him until an ulcer had appeared at the floor of the mouth. He ligated both external carotids, but did not think it was necessary to perform a preliminary tracheotomy. The hæmorrhage was no greater than would follow the amputation of leg where a constrictor had been applied. This patient, however, died of aspiration pneumonia. Dr. Eisendrath asked Dr. Crile whether in such radical operations as this—carcinoma of the tongue, or carcinoma of the glands of the neck—he found it necessary to perform a preliminary tracheotomy. Fourth, given a case of

carcinoma of the lip in the early stage, or a carcinoma of the tongue which had not advanced to an extensive degree, would the operation be as radical as that which he had outlined, namely, removing the whole cervical lymph node area?

DR. D. W. GRAHAM said that, regarding the removal of the jugular vein, he had been accustomed, when he wanted to dissect out a carcinomatous mass in the region, to cut the vein and muscle just below the tumor, and following down towards the clavicle as far as was necessary; then ligating below, and turning the other end up with the tumor as high as it was deemed necessary to go. In these cases he had discovered that the lumen of the jugular vein was sometimes obliterated and frequently partially obliterated, so that beginning there it was probably easier to remove the vein down from that point than it would be to start just above the clavicle, although he could see how Dr. Crile's method might be better in some instances.

Regarding the removal of the Gasserian ganglion, he thought there was some advantage in what Dr. Crile had recommended in the use of the retractors exhibited. These narrow retractors would take up much less space than those surgeons had been accustomed to using. To enucleate the ganglion, he had usually employed blunt, curved scissors or a short-beaked, blunt hook. However, this dental instrument (the dental crowder, as he called it) seemed an ideal one, in that it was sharper and would enable one to do quicker work.

DR. CRILE, in closing the discussion said that in the case of brain anæmia, sensation was greatly lowered. Here Dr. Ochsner had made a distinct advance in the work from the point at which he left off.

Replying to the questions asked by Dr. Eisendrath, he said it was interesting to note that there was very little hæmorrhage after the clamp was taken off. The vessels were seen during the course of the operation, and after the removal of the clamps very little hæmorrhage ensued. The operative field was clean, so that one could pick up the vessels and tie them. He had never seen a case of cerebral embolism following the method he had described. However, if one squeezed the clamp or clamps too tightly, there might be the possibility of the formation of an embolus. Particularly would a thrombus be likely to be produced, and later embolism, if one were rough in his manipulations.

He had not for some time resorted to preliminary tracheotomy. He followed the teachings of some of his colleagues in putting patients in the upright position as early as possible after operations. He said he had a strong conviction that the foundation of a number of cases of septic pneumonia was laid at the time of the operation by too great exposure. When patients inhaled blood there was greater risk of septic pneumonia occurring. He was firmly convinced that with improved methods there were not as many cases of septic pneumonia now as formerly.

He would not make two operations at the same time in a case of cancer of the tongue, if he could avoid it. He would do the mouth operation first, possibly, and later on the operation on the neck. He would go low down in the neck, as he had pointed out in the demonstration.

As to whether or not, in an early case of cancer of the lip, he would make entire block dissection, he said he would not do so, but would do a regional block. In every case of superficial carcinoma he took out regionally, he had reason to believe that it was drained by the lymphatic area. He had this feeling, that as long as the glands of the neck were involved, no one knew or could tell in which direction the metastasis went, consequently when the glands were involved excision of at least half of the neck should be made.

In conclusion, he emphasized the point that it was much easier to do the larger operation than the smaller one.

COMBINED SUPERIOR TIBIOFIBULAR AND ASTRAGALOFIBULAR OSTEOPLASTY AS A MEANS OF PREVENTING SHORTENING OF THE LEG DURING ADOLESCENCE FOLLOWING EXTENSIVE OSTEOMYELITIS.

DR. NORMAN KERR read a paper with the above title, for which see page 425.

DR. A. J. OCHSNER said there was one feature in connection with the surgical treatment of osteomyelitis which was not so generally applied as it should be. In cases of acute osteomyelitis of the long bones, in which there was an apparent destruction of the entire shaft, the activity of the periosteum in the formation

of a new bone was stimulated to a greater extent by the presence of the old shaft than by anything else that could be done. Some eighteen or nineteen years ago Dr. Parkes demonstrated the fact that in acute osteomyelitis almost a normal limb could be secured in practically every case, provided the primary operation consisted in splitting the periosteum from end to end and leaving the shaft as an irritant for the formation of the involucrum which usually resulted in almost a perfect new bone.

DR. E. WYLLYS ANDREWS said that Dr. Kerr was to be congratulated on obtaining such a result in the case reported in a comparatively short time, as usually the results in such cases could only be secured in years, rather than months.

Operations for sequestrotomy must not be done too early. A great deal of interest attaches to the formation of an involucrum. This, when allowed to occur, insures proper length and support.

In this connection he would make a plea for the use of the Moorhof bone plug in cases where bone defects were to be filled. He thought there was nothing more advantageous than this plug in this and similar classes of cases. The materials of this bone plug mixture were iodoform, spermaceti, and oleum sesami. These ingredients were slowly heated to 100° C., and when allowed to cool would form a soft solid which would remain solid at the temperature of the body, and for use it was heated to 50° C., being constantly stirred to keep the iodoform evenly distributed. This material would fill a cavity in bone just as well as the dental surgeon filled a cavity with amalgam. The wound could be closed over it. There would soon be the formation of new bone, gradually displacing the plug, and primary healing of the wound.

CONGENITAL ATRESIA OF THE ILEUM.

DR. WILLIAM HESSERT exhibited a specimen removed from an infant, five days old. The history, as given by the mother, was that the baby had not had a bowel movement since birth, and the attending physician had informed him that at birth there was no escape of meconium. The patient showed the typical symptoms of intestinal obstruction—vomiting, distended abdomen, and was in a low condition. On opening the abdomen,

dilated coils of intestine presented, and in following them down he found that the ileum ended below in a blind pouch. It was much larger then than it was now. It was filled with fæces to almost the size of one's fist. There was no connection between the ileum and the colon. The ileum ended in a blind pouch, and the colon was to the right, greatly contracted. It was impossible to make any sort of anastomosis between the ileum and colon. He opened the blind pouch, allowed the gases and fæces to escape, and then sutured it to the abdominal wound. The child died the next day. He presented the case as a pathological curiosity.

BOOK REVIEWS.

GALL-STONES AND THEIR SURGICAL TREATMENT. By B. G. A. MOYNIHAN, M. S. (London), F. R. C. S., Senior Assistant Surgeon to Leeds General Infirmary, Leeds, England. *Second edition, revised and enlarged.* Octavo, 458 pages. Philadelphia and London. W. B. Saunders & Co., 1905.

That a book devoted exclusively to the consideration of the diseases produced by gall-stones should in little less than a year require a second edition is sufficient evidence both of the value of the work and the interest of the profession in the subject. Needless to say, the author has discussed the questions involved with clearness and force. The book is well printed, and the illustrations excellent, particularly the half-tones and colored plates. A valuable chapter on congenital abnormalities of the bile-tracts has been added to this edition. The exposition of the operative technique is lucid and clearly illustrated. The chapter on the symptoms and signs of gall-bladder disease is especially valuable and complete, and ought of itself to give this volume a place not only on the shelves of the surgeon, but on those of the general practitioner and internist as well.

A. T. BRISTOW.

SURGICAL DIAGNOSIS. A Manual for Practitioners of Medicine and Surgery. By OTTO G. T. KILIANI, M.D., Surgeon to the German Hospital, New York. William Wood & Co., New York. 1905.

The purpose of the present work is to educate the physician to differentiate between medical and surgical cases, or, in other words, to assist the practitioner in deciding the difficult question whether or not a disease needs surgical interference.

The introductory chapter deals with the methods of examination and injuries and wounds in general. This chapter, which occupies only 25 pages, is altogether too elementary as an introduction to such a work. It lacks system and complete-

ness, and leaves the reader poorly equipped to understand that which follows.

The author takes up the injuries and diseases of the various organs and tissues of the body, the special parts being arranged in anatomical order, beginning at the head.

Each chapter deals with a special part of the body. The various surgical conditions which may arise are described, detailing in a few words the etiology, symptoms, diagnosis and differential diagnosis of each injury or disease, and further stating the indications and contraindications for operation, and the results to be expected from surgical interference.

The book is not written for the surgeon, but for the general practitioner. The author assumes that the physician already knows medical diagnosis, and does not burden him with facts and theories which are already at his command in the works on medical diagnosis. Accepting the book in this light, the work will find a wide sphere of usefulness.

PAUL PILCHER.

THE SURGICAL TREATMENT OF CHRONIC SUPPURATION OF THE MIDDLE EAR AND MASTOID. By SEYMOUR OPPENHEIMER, M.D., of New York. P. Blakiston's Son & Co., Philadelphia.

A very comprehensive treatise of 425 pages, beautifully printed and illustrated on good paper and well bound, apparently intended as a companion volume to Whiting's "The Modern Mastoid Operation," by the same publishers.

The following points receive especial emphasis: The prohibition of the use of the galvano-cautery in the depths of the external auditory canal or in the tympanic cavity; the hazard attending removal of masses of granulation tissue springing from the tympanic roof; the trial of persistent and thorough local treatment before recommending the more serious surgical attacks; the doing of ossiculectomy, as a rule, before deciding as to the necessity for a radical operation on the mastoid process; the use of adrenalin chloride to control the bleeding in ossiculectomy; the caution against interference with the stapes in suppurative cases; the fact that the conservation of the functional ability of the ear is to be considered unless there is danger

of the extension of the suppurative process, when, of course, the more important indication is to forward good drainage. The author advises prolonged after-treatment, in cases in which ossiculectomy has been done, before entertaining the belief that the radical operation is unavoidable. He also states that "it is very well proved . . . that we can obtain little or no evidence of any practical value" "by the external appearance of the mastoid exterior, so that one can avoid the lateral sinus," etc., p. 190; also that "the cranial cavity is never lower than the spina" (supra-meatum), p. 196; also that "the simple opening of the mastoid process, without entering the antrum, has no place at all in the treatment of chronic aural suppuration," p. 238. He does not favor primary closure of the mastoid wound nor Blake's blood-clot method. He says truly that "the radical operation . . . is only relatively so, as it may be impossible to remove all the diseased tissue that may extend to the finer cellular spaces," p. 280. He fails to note the fact that the facial nerve may take an abnormal course through the mastoid process and elsewhere.

The author describes the various classical operations and the numerous methods of forming flaps to cover the wound in the bone. He has brought together much matter largely collated from the more recent writers.

HENRY A. ALDERTON.

MINOR AND OPERATIVE SURGERY, INCLUDING BANDAGING.

By HENRY R. WHARTON, M.D. Sixth Edition. Lea Brothers & Co., Philadelphia and New York. 1905.

This volume of 650 pages is the sixth edition of a surgical text-book which has enjoyed such popularity as to call for three new editions since 1901, at which time the third edition was reviewed by the writer in the June number of the *ANNALS OF SURGERY*. Its title has been changed from "Minor Surgery and Bandaging" to that which appears above. This has been done because of a broadening of the scope of the work so as to include descriptions of many surgical procedures which are far beyond the realm of so-called Minor Surgery. The chapters on Bandaging, Asepsis, Fractures, Wounds, Sprains, Anæsthetics,

X-Rays, etc., have been enlarged and revised so as to meet the requirements of surgical progress. To the last section there have been added descriptions of those operations which are most commonly practiced both by the student on the cadaver and the general hospital surgeon. Here include Ligation of Arteries, Amputations, Operations on Nerves and Tendons. Excision of Joints, Tracheotomy, Intestinal Anastomosis, Appendicitis, Strangulated Hernia, etc.

The book is profusely and well illustrated.

WALTER A. SHERWOOD.

A COMPEND OF OPERATIVE GYNÆCOLOGY. By WILLIAM SEAMAN BAINBRIDGE, M.D., Adjunct Professor of Operative Gynæcology on the Cadaver, New York Post-Graduate School and Hospital. 12 mo. Pp. 76. The Grafton Press, New York City.

In this book the various operations of gynæcology are described concisely, with special reference to their practical relations. It has been planned more especially for the help of post-graduate students in following the author's course of operations upon the cadaver. Various abdominal operations are included in the scope of the work, the view of the author being that the gynæcologist is an abdominal surgeon, who should be able to cope with any abdominal condition that might be met with. The book contains many admirable suggestions, and is interesting especially as an index to the field and methods of the author's instruction.

LEWIS S. PILCHER.

A TREATISE ON THE DISEASES OF INFANCY AND CHILDHOOD. By HENRY KOPLIK, M.D., Pediatrist to Mt. Sinai Hospital, New York. New Second Edition. Revised and Enlarged. Lea Brothers & Co., Publishers, Philadelphia and New York. 1905.

Dr. Koplik has produced a most excellent treatise on the diseases of infancy and childhood. It embraces as well a consideration of the physiology and pathology of the new-born, and the management of infant feeding.

The advances in the field of pediatrics in the last few years have been most striking, and although the author does not quote to any extent from other works, yet he has evidently kept in touch with the work of others. The present book reflects very largely the personality of the author, rather than the consensus of opinions of other workers in this field. He advocates the Rotch method of percentage feeding.

His book is written so as to be equally useful to the country and city physician, and describes clearly the methods of home modification of milk as carried out both in the country and the city districts.

The clinical character of the work has been preserved throughout, and as a treatise on the diseases of children, and their proper management, Dr. Koplik has produced a most practical and scientific work which will be acceptable alike to students and physicians.

PAUL M. PILCHER.

CLINICAL APPLIED ANATOMY OR THE ANATOMY OF MEDICINE AND SURGERY. By CHARLES R. BOX, M.D., B. S., M.R.C.P. (Lond.), F.R.C.S. (Eng.), W. Mc ADAM ECCLES, and M.S. (Lond.). F.R.C.S. (Eng.). Illustrated. P. Blakiston's Son & Co. Philadelphia. 1906.

This work differs from most of the text-books on applied anatomy in that it deals almost exclusively with the clinical side of the subject and is written from the view-point of the practitioner of medicine and surgery rather than that of the anatomist. As is stated in the preface, the authors have attempted to follow the lines suggested by John Hilton in his classical treatise on "Rest and Pain," which was published in 1862. The important influence of anatomy on the occurrence and course of disease and injury is well illustrated. Purely surgical anatomy, which is detailed in the various text-books on operative surgery, is purposely omitted.

There are twenty chapters in all, the first ones being given to the consideration of Inflammation, Tuberculosis, Syphilis, Gangrene, and the specific fevers. Then follow chapters on Tumors, Fractures, Dislocations and Diseases of the Bones,

Joints, Muscles, Tendons and Bursæ. The remaining sections include diseases of the nervous, vascular, lymphatic, respiratory, digestive and genito-urinary systems, diseases of the ductless glands, the eye and the ear.

The chapters on diseases of the nervous and vascular systems are the most complete.

The entire work is well written and gives expression to many original ideas. The book is illustrated by means of forty-five plates, twelve of which are colored.

WALTER A. SHERWOOD.

CORRESPONDENCE.

REMOVAL OF HEMORRHOIDS BY EXCISION AND SUTURE.

TO THE EDITOR OF THE ANNALS OF SURGERY:

YOUR article as it appears in the August issue of the ANNALS OF SURGERY describing an original operation for hemorrhoids, has attracted my attention. In the *British Medical Journal* for February 28, 1903, A. B. Mitchell describes an original technic for this operation. I can see very little difference in his operation and yours; indeed, they are similar in every respect save one: you incise the mucocutaneous border before applying the forceps, he does not.

The simplicity and effectiveness of Mitchell's operation attracted me when it appeared, and I have resorted to it in many instances. It is followed by less pain, shortens convalescence, and there are no tags or irritable fissures left. In one instance, however, I had hemorrhage which the continuous suture did not control.

I take the liberty of calling your attention to this operation, for it is another illustration of how two surgeons acting independently may devise the same technic; and it appears to me that some acknowledgement should be made of Mr. Mitchell's work.

Yours very truly,

RICHARD DOUGLAS.

NASHVILLE, TENN., August 14, 1906.

CHEWING-GUM AND HAM-RIND AS NUCLEI OF VESICAL CALCULI.

TO THE EDITOR OF THE ANNALS OF SURGERY:

THE case of chewing-gum nucleus of a vesical calculus reported by Dr. E. B. Kenner in the August issue of the ANNALS OF SURGERY has brought to my mind a similar case under my own observation some years ago which has never been reported.

I venture to report it now as a contribution to the general subject of foreign bodies introduced per urethram into the bladder.

In 1892, in the month of July, a man came to me complaining of vesical irritation. He was suffering not only from an increased desire to urinate but the act was accompanied and followed by pain. The pain during the act was located in the glans penis; that following was located over the bladder. There was a little elevation of temperature. The constitutional symptoms however were not marked. The trouble had arisen quite suddenly. Examination of the urine showed some mucus and blood. No adequate explanation of the condition could be found. The sound failed to show the presence of calculus, and he had no discharge from the urethra, nor had he ever had gonorrhœa.

Treatment for a cystitis of unknown origin was instituted and failing to improve sufficiently in a few days he passed out of my care for several weeks. Then he returned in worse condition than he was before. Sounding at this time gave positive evidence of stone and he finally agreed to operation. Through a median perineal incision a phosphatic calculus was removed, the nucleus of which was a mass of white wax chewing-gum. He made a good recovery.

He then confessed that this chewing-gum had been introduced only a few days before he began to suffer from it. His admissions and peculiarity of manner proved him to be a sexual pervert.

On June 8, 1902, he again presented himself and without any attempt to deceive me related that while introducing a piece of meat into his urethra it had gotten beyond his control and he could not get it out. He insisted that it was yet in the canal, that he could feel it and that if he had a pair of forceps he could get it himself. Examination proved him to be mistaken in this and he was sent to the hospital, where a suprapubic cystotomy was immediately done and the meat extracted. It proved to be a piece of the rind of ham four inches long and almost as large as the little finger in appearance!

B. VAN SWERINGEN, M.D.

FORT WAYNE, IND., August 11, 1906.